ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 61. No. 14. 220 Broadway, New York, April 8, 1909.

TABLE OF CONTENTS.

LEADING ARTICLES:	Page.
The Market House Bridge at Monterrey, Mexico (illustrated); Lloyd B. Smith, Assoc. M. Am. Soc. C. E.	399
The Write-Up	370
The Development of Telephony (illustrated); Sergius P. Grace, M. Am. Inst. E. E.	371
Portland Cement for Use in the Tropics; Richard K. Meade	373
Grade and Line Revision, and a Concrete Voussoir Arch Bridge; Cumberland Valley Railway (illustrated)	377
The Development of the Illinois Experiment Station; L. P. Breckenridge, M. Am. Soc. M. E.	377
Coal Sampling and Analysis; N. W. Lord, M. Am. Inst. M. E.	378
A 10-in. Steel Water-Supply Main for the Water-Works of Montcalm, P. Q. (illustrated); Raoul Rinfret	379
A Cost Record System Used for Work Done by Day Labor (illustrated)	380
The Design of Intakes for Hydro-Electric Plants (illustrated); Jean. Bart. Balcomb, Assoc. M. Am. Inst. E. E.	382
Concrete-Lined Mine Shafts at Filbert, Pa. (illustrated)	383
Julius William Schaub, M. Am. Soc. C. E (with portrait)	393
The Governor of Wisconsin on Water-Power Franchises	393
A Suction Ash Conveyor (illustrated)	394
The Selection and Purchase of Coal for Boiler Furnaces; D. T. Randall, M. Am. Soc. M. E.	395
Notes from the Engineering Schools	396

EDITORIAL	Page. 385
Boiler Furnace Design and the Local Coal Market—New York City Water-Supply Matters in the Proposed New Charter—The "Hush Pipe" as a Means of Hiding Water Waste in Cities—A Bright Outlook for the Census of 1910.	
Clear Specifying, and the Nova Scotian Steel-Coal Lawsuit	386
LETTERS TO THE EDITOR	387
Against Sweeping Pullmen and Other Railway Cars While Occupied; Jos. E. Craig—Water Consumption and Waste in New York City and Elsewhere; Walter M. Smith—A Poker Problem for Calculators; William Hoffman—A Lawsuit Over a Contract for Building an Embankment; "A Witness"—More Concerning "Professorial Researches"; B; Geo. H. Gibson—Experience with Dike Protection of River Banks at Pine Bluff, Ark. (illustrated); Assistant Engineer—The Destruction of a Pier of the Arkansas River Bridge and Other Instances of River Bank Erosion (illustrated); Chas. H. Miller—The "Type Characteristic" as a Criterion of Water-wheel Runners; B. F. Groat; S. J. Zowski—A Criticism of the Work of the Joint Committee on Concrete and Reinforced Concrete; C. A. P. Turner—Discharge Formulas for Cast-Iron Pipe; George L. Bean—The Panama Canal; R. W. Hebard.	
ENGINEERING NEWS OF THE WEEK	397
PERSONALS	398
ENGINEERING SOCIETIES	398

The Market House Bridge at Monterrey, Mexico.

By LLOYD B. SMITH,* Assoc. M. Am. Soc. C. E.

A novel application of reinforced concrete is shown in the accompanying views of a market house in the city of Monterrey, Mexico, supported on a reinforced-concrete bridge of two arches of 74 ft. 2 in. span each, across the Santa Catarina River. The site was formerly occupied by a wooden market building on a through truss bridge of steel of two 75 ft. spans. The old bridge and market house were destroyed by fire in January, 1908, and in rebuilding the structure it was decided to use reinforced concrete throughout as being non-combustible.

The new bridge is of the Luten type and is shown in longitudinal and transverse sections in Fig. 2. The old bridge had been supported on piers and abutments of cyclopean masonry. The stone pier was wrecked to a level of one foot above the bed of the river and the new pier 7 ft. thick at the base and 6 ft. thick at the springings was erected on this foundation. The abutments were wrecked to 6 ft. below the bed of the stream and the new abutments built upon them as a foundation, but extending 6 ft. back of the old stone abutments which were 7 ft. thick. The new abutments were thus 13 ft. thick supported on compact gravel at the rear. Large rocks from the wrecked masonry were embedded in the concrete of the new abutments, and spaced not nearer than 12 ins. apart horizontally and 3 ins. vertically. The concrete throughout the bridge was composed of one part cement, 2½ parts sand and five parts river gravel.

The stability of the 13-ft. abutment for the 74-ft. span was a question of considerable discussion, since, as is always the case, its dimensions are governed largely by the conditions of the foundations which may vary greatly. When centers were struck the deflection was not greater than 3/32-in. on either arch and no cracks of any kind occurred except as intended at the expansion joints at each end of the span, thus establishing the fact that for the given foundations the abutments had been properly proportioned.

*Vice-President, Topeka Bridge & Iron Co., Topeka, Kansas.

The arches were reinforced with ¾-in. steel rods spaced 12 ins. c. to c., arranged in one series, but crossing the arch ring at alternate points, one-third, one-half and two-thirds the distance from springing to crown. Alternate rods are anchored in the face and back of abutments. The transverse reinforcement consists of ¾-in. rods spaced about 4 ft., and extending upwards into the spandrel walls which are also reinforced longitudinally in the coping from expansion joint to expansion joint.

The centering was extremely light, made possible by the use of columns consisting of 2 × 6 and 2 × 8-in. timbers in pairs arranged in the form of a T, that is with the major dimensions of the 2 × 6 transverse to the major dimensions of the 2 × 8, and made to act together as a column by wrapping at intervals of 3 or 4 ft. with No. 10 wire. No wedges were used for striking centers, but when the time arrived to strike centers the wires were cut, allowing each member of the compound column to buckle separately, thus subjecting the arch to stress very gradually

The arches were concreted in longitudinal rings continuous from abutment to middle of pier, and the spandrel walls connected monolithically with the ring to avoid the unsightly ragged joint that otherwise would appear above the arch ring. Immediately after completion of the arch, the earth fill was tamped into place to the level of the roadway, and after the fill was completed, and but eight days after the completion of the arch rings, the centers were struck.

The centers were thus removed before the completion of the superstructure; this step not only constitutes a desirable feature in the construction of any arch, but was quite indispensable in this structure. Thus had the concrete market house been completed before striking centers it would undoubtedly have been seriously cracked and strained by the settlement of the arches, even though that was but 3 32-in. at crown. The writer finds that in any arch the elimination of the settlement stresses by striking centers before erecting copings or railings will eliminate almost entirely the unsightly cracks that are so frequently found in arch bridge railings.

The expansion joints consist simply of a vertical plane of separation in the spandrel wall at each end of the span. To prevent seepage from the earth fill discoloring the face of the spandrels a vertical groove is formed with an outlet below to serve as a drain. The expansion joints opened about 1/16-in. when centers were struck.

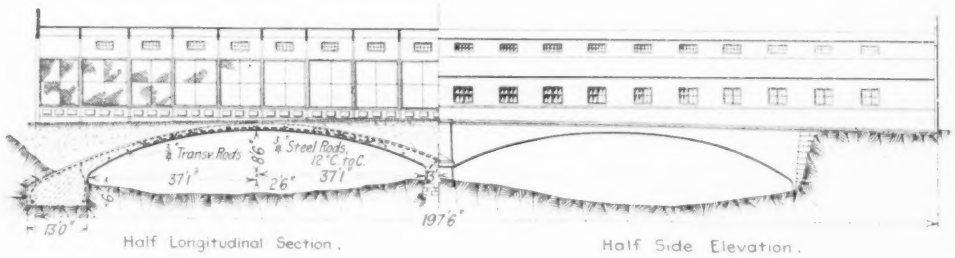
A CONCRETE BRIDGE CARRYING AN ARCADE OF STORES.

The general construction of the market building is shown in the accompanying photographs. This building is 200 ft. long by 52 ft. wide. The height of the outside walls is 10 ft. 6 ins., and the highest point of the monitor is 25 ft. 6 ins. above the floor. A clear roadway of 19 ft. 6 ins. is left through the center of the bridge. The floor space on each side of this roadway is divided into 20 market-stalls, each 10 ft. wide by 16 ft. 3 ins. long. The building is entirely of reinforced concrete, with the exception of the wooden counters, the expanded metal screens in the front of the stalls and the windows. The walls are 3 ins. thick, reinforced both horizontally and vertically with 5/16-in. plain round rods 12 ins. c. to c. The outside walls have no studding or transverse supports other than the partition walls between the rooms. The roof slab is reinforced with No. 24 gage expanded metal, and is supported on 3 × 8-in. concrete purlins placed 5 ft. 1½ ins. c. to c. and reinforced with 5/16-in. rods. These purlins were made in wooden forms on the ground and hoisted to position. The window frames are made of 3-in. channels; and 3-in. channels are bent over the roadway to give form to the intrados of the concrete arches supporting the monitor.

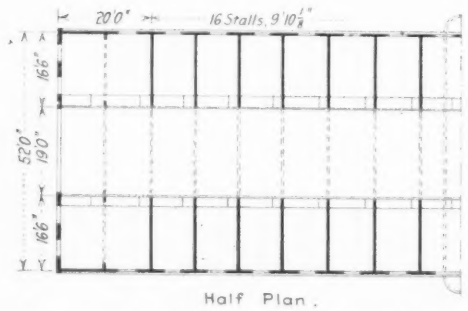
Work was commenced April 1, and the bridge proper was completed June 20. The building was

commenced ten days later and completed October 1.

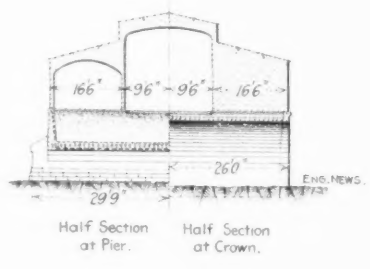
Alfred Giles, of San Antonio, Tex., was the supervising architect, and the field work was in charge of his engineer, J. F. Woodyard, Jr., who also designed the market building. Both bridge and market house were erected by the Topeka Bridge & Iron Co., of Topeka, Kan.



Half Longitudinal Section. Half Side Elevation.



Half Plan.



Half Section at Pier. Half Section at Crown.

FIG. 2. DETAILS OF THE MARKET HOUSE BRIDGE, MONTERREY, MEX.

The Write-Up.*

The exploitation of a manufactured product in the guise of reading matter is called a "write-up." It is not a literary word and it does not represent literature; it is the exponent of a commercial idea in the guise of scientific or technical information.

In the daily press you find yourself reading a paragraph that begins with a seductive reference to the "grandeur that was Greece or the glory that was Rome" and ends by recommending Snooks' soap. In the financial press you become absorbed in a picturesque account of South African mining only to discover that you have been inveigled into a consideration of the opportunity for sudden wealth presented by the shares of the Great Bullion Extended Mining Co. in southern Nevada. In a technical paper you plunge into a turbid description of pumps and their work in mines, to find that the purpose of the article is to recommend the Jones centrifugal pump manufactured by the Jones Co., of Jonesville, Tenn.

If you are good natured, not too busy, and possessed of a sense of humor, you laugh at yours if as the victim of a practical joke; if, however, your liver is sluggish, or you are a busy man, or do not appreciate foolery, you kick yourself for being deceived and there is developed a longing to express your sentiments to the responsible editor. Undoubtedly, the "write-up" is in the nature of an impertinence.

But beside the cruder forms of this insidious method of gaining publicity without payment, there are unaffected descriptions of manufactured products that appear in trade and technical papers. Thus the write-up becomes a specious indorsement of one advertiser's wares at the expense of the other advertisers, and eventually it is to the detriment even of the favored individual. For it is obvious that if a "write-up" is not as trustworthy as matter coming from an unprejudiced source, then it lessens the interest of the reading portion of the paper and renders the advertising less valuable. There is no escape from this conclusion.

The representative of a machinery firm brings a description of his works, with a photograph of the establishment, and wants it published as reading matter. The sight of it in the paper may gratify the members of that particular firm, but it is certain that it is of value to no one else, for the products of manufacture do not depend for their excellence on the appearance of the building in which they are made. Moreover, the insertion of such an article is not fair, for the advertiser is simply asking for so much gratuitous advertising in a part of the paper where he thinks he may get exceptional publicity. The reader is annoyed, for the "write-up" is not of interest to him; he does not rate Smith's pumps by the look of Smith's factory.

It comes to this, that anything which lessens the interest of the reading pages tends to hinder the purpose of the advertising; protect the reader and you safeguard the advertiser, for no one that has become annoyed or displeased with the reading matter is likely to spend much time over the advertisements; on the contrary, it is the satisfactory character of the articles that will cause a reader to hold a paper in his hands long enough to turn over the pages of advertisements.

But we shall be told that there are write-ups and write-ups; that what we have said may apply to certain forms of this method, but it does an injustice to the skillful write-up, which gives reliable information while incidentally fulfilling another purpose. This is a matter of opinion. Even the best of the stuff sent broadcast by the publicity bureaus of manufacturing companies is prejudiced; among the facts lurk fallacies; between the scientific data are sandwiched the exaggerations of a salesman. It may be a long way from the fervid rot of a corn doctor to the pseudo-scientific literature of a publicity manager, but there is every gradation between them and they are tainted by the same fatal defect.

It is the editor's duty to protect his reader; in so doing he advances the best interests of the advertiser, for by such methods the advertiser is given the best opportunity to win the attention of the reader. For this reason the signed article that masquerades as an independent statement, while really the puff of an advertiser, is particularly objectionable.

Not content with self-laudatory paragraphs, some manufacturing firms employ technical men to write articles for publication, in which the principles underlying certain types of machinery are specially advocated, so as to prepare the way for the reception of a recommendation of the machines themselves. Of course, there is no reason why the inventor or the manufacturer of a machine should not tell the truth in an interesting way, and it happens often that information concerning processes and devices can be obtained only from such sources. In that case, the position of the author should be frankly stated; it certainly would be deemed a courtesy to the reader and would tend to inspire confidence. Any feature of the reading pages that wins the confidence or commands the respect of the reader, by so much increases the value of the service given to the advertiser.

Is this Utopian and impracticable? We trust not. It is sound business, not poetry. The practice of recommending mining stocks and puffing companies in the editorial columns because they advertise their prospectuses on another page has died out in America, that is, among journals of any standing. In London the mining papers are still subventioned in various ways; the mining company pays for an account of its meeting, for the publication of reports, for reprints of the speech made by its chairman, and for sundry other ways in which it gets favorable publicity; the papers distribute praise or blame, or maintain an ominous silence, according to the amount of advertising taken with them. Paid matter appears in the heart of the reading pages, the right hand watches the left, the business department and the editorial are partners in a sordid business. And what is the result? The advertising pages have scarcely any value. Why? Because the reading matter is unreliable. There you have it.

In America the leading mining journals do not insert paid matter in their reading pages, and the only blemish is the "write-up," which is a sop to Verberus, the donation of extra publicity gratuitously to those who advertise, or are expected to advertise, in the paper. This reminds us of a petty form of "graft" operated in connection with write-ups. A firm that does not advertise with you will send a write-up "because it is interesting" and it will have the cheek to ask you to publish it to the end that its products may be advertised free. This does an injustice to the advertiser that pays. The excuse to be made for the "write-up" is that it is a courtesy to a client, a concession to one with whom you are doing mutually profitable and honorable business, therefore when a non-advertiser asks for advertising space in your reading pages he exhibits monumental effrontery. Your reader does not even have the satisfaction of turning to the advertising pages for further information. A young man obtained a testimonial as to his ability from his own mother. That is the "write-up" in its simplest form—interesting to the family!

*Editorial in the "Mining and Scientific Press" of Dec. 26, 1908.

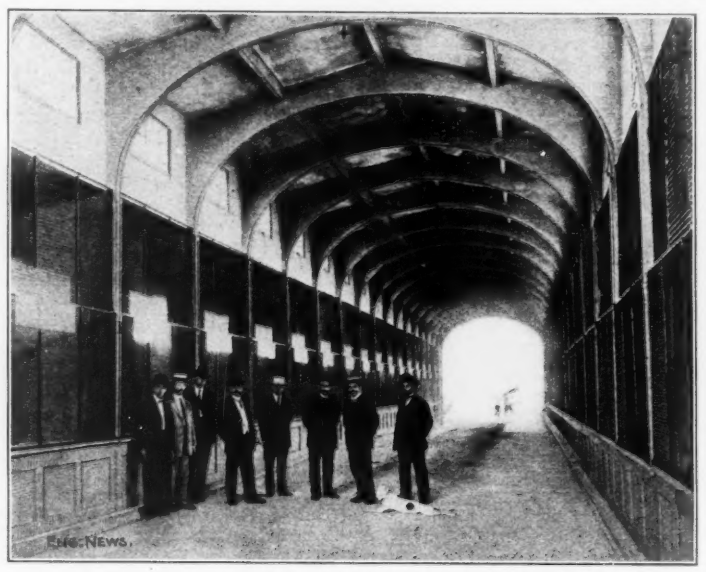


FIG. 3. THE ARCADE ON THE MONTERREY BRIDGE.

THE EFFECT OF CALCIUM ALUMINATE upon Mortars as briefly reported by Mr. Henry S. Spackman in our issue of Dec. 10, 1908, p. 658, has been more exhaustively treated by the same author in "The Journal of the Franklin Institute" for March, 1909, p. 186. For the benefit of those of our readers who did not see the paper in our columns we would say that Mr. Spackman has found that calcium aluminate, mixed with lime and certain more solid aggregate such as shale or clay ground to fineness, makes a remarkably strong cement without the need of burning. It was also found that the aluminate added to natural cement gives it slow setting properties and also a rapid increase in strength, properties which now make Portland cement so much superior to natural. These studies are very thoroughly explained in the Franklin Institute paper, which is too long to be abstracted in this journal.

EXTENSIVE MUNICIPAL IMPROVEMENTS at San Francisco are proposed for early construction. Among these is a sewerage system to cost $4,000,000. It is expected that parts of this sewerage system will be let in separate contracts during the year, in values ranging from $50,000 to $300,000. The auxiliary water-supply system, a plan for which was outlined in our issue of Jan. 16, 1908, will also be started this year. The first contracts to be let on this system will include 50 reinforced-concrete fire cisterns, 91 miles of cast-iron water pipe, two salt-water pumping stations and two reinforced-concrete reservoirs. Mr. Robert Loughery is Secretary of the Board of Public Works, and Mr. Marsden Mansen, M. Am. Soc. C. E., is City Engineer of San Francisco.

The Development of Telephony.*

By SERGIUS P. GRACE,† M. Am. Inst. E. E.

The transmission of intelligence by the telegraph had, by the middle of the last century, reached a fair state of development, and it was but natural that the inventors of telegraphic apparatus should turn their attention to the creation of telegraphs which would not require skilled operators. This was accomplished in the early 70's by the invention of the printing telegraph whose step by step mechanism would reproduce at the receiving end of the line any character or letter struck at the transmitting end. One of the earliest successful types of printing telegraph was invented by Elisha Gray. Scientists and laymen alike had dreamed of the long

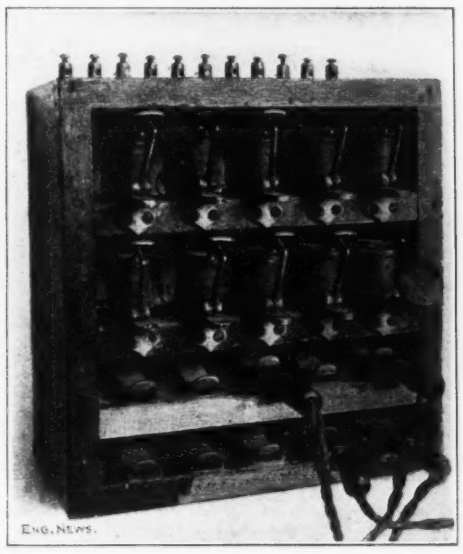


Fig. 1. An Early Telephone Switchboard. Made by Charles Williams, Boston.

distance transmission of articulate speech, but its accomplishment seemed so far in the future that when the printing telegraph was developed it was hailed as one of the great inventions of the century, and it was predicted that it would have a most profound influence upon the business and social relations of the country

As far back as 1874 the city of Pittsburg was supplied with a printing telegraph system, making use of the Gray printers. Many of the iron and steel companies had printers in their offices, connected to a central exchange located on Fifth Ave. in the First National Bank Building. These printers were operated by the Central District and Printing Telegraph Co., the "central district" part of the name referring to the messenger branch of the business.

When in the memorable year of 1875, Alexander Graham Bell gave to the waiting world the masterpiece invention of the century, the electric telephone, there were many who considered it only a scientific toy; but the discerning ones saw that properly developed it was going to be the greatest labor saving invention of the ages. Among the latter was T. B. A. David, the President of the Central District and Printing Telegraph Co. In the fall of 1876 he investigated the electric telephone system of Bell, and shortly afterwards he witnessed a trial of a Bell telephone receiver in combination with the recently invented carbon transmitter of Thomas A. Edison. Mr. David, with his broad mind, instantly saw the possibilities of the telephone and determined that Pittsburg should be one of the first cities in the country to exploit this invention. Having control of the lines of the Central District and Printing Telegraph Co. he was in a good position to introduce the telephone.

The telephone exchange established by Mr. David represented the Western Union Telegraph Co., who at that time were fighting the National Bell Telephone Co. for control of the telephone field. The Bell Company also established an exchange in Pittsburg, but in the year 1880, at the close of the famous litigation between these rival companies, the two exchanges in Pittsburg were consolidated. However, the old name of the Central District and Printing Telegraph Co. was retained because of the very favorable charter which it had secured from the state. This explains the peculiar name of one of the largest of the Bell licensee companies, and brings out the fact that originally it was chartered to exploit the printing telegraph.

From 1876 to 1886 the telephone all over the country had a struggle for existence. The telephones were of the crudest type, the switchboards were simply adaptations of telegraph boards, and the vast amount of iron wire strung on roof tops was a combination not productive of a telephone service such as would inspire the confidence of the public. Added to these handicaps the introduction of the electric trolley and electric light and power service made the grounded telephone lines extremely noisy by induction. As an example of the crude switchboards of early days a switchboard is shown in Fig. 1, which was made by Charles Williams in his old Boston shop in the early 80's. This board was used for a number of years for a private branch exchange in the Dixmont Insane Asylum.

From 1886 to 1896 the various telephone companies, assisted by the engineering departments of the American Bell Telephone Co. and the Western Electric Co., made heroic efforts to develop apparatus and lines suitable for the transmission of electrical energy for articulate speech. It was early found that iron wire, because of its high resistance and inductance, seriously retarded telephone speech, but copper wire could not be used because of its low tensile strength. It was not until Thomas B. Doolittle, of the engineering staff of the American Bell Telephone Co., developed the process of hard drawing copper wire that copper could be used at all for outside lines in the development of telegraphy and telephony.

Even with the advent of metallic circuits many troubles were experienced with the telephone lines from external induction from electric light and power wires, making the telephone lines noisy, and from induction caused by neighboring telephone circuits, resulting in the phenomenon called "cross talk." A system of transpositions had to be developed which would keep the lines reasonably free from induction from outside sources and yet which would prevent "cross talk" from one telephone circuit to another. "Cross talk" is overhearing from one circuit to another, the current being induced electromagnetically and electrostatically without metallic contact.

Because of the large number of wires required in telephony it became imperative to design a cable which would accommodate in a small space many hundreds of wires. After a long period of development work Mr. Patterson of the Western Electric Co. finally developed his paper insulated, lead covered, telephone cable, which still remains the standard of the telephone world.

The development of switchboard equipment and apparatus was also rapid in this period, and when the multiple magneto switchboard with self-restoring drops was invented it was considered by some that the limit of switchboard improvement had been nearly reached. In the early 90's it was clearly seen by discerning telephone engineers that to meet the demands of service in large cities a faster and more efficient type of central office switchboard must be developed than the old magneto. Furthermore, in the old magneto system, batteries were placed in each telephone for the operation of the transmitter, and an alternating current generator was supplied for throwing the drop at the central office. The maintaining of these thousands of distributed batteries and alternating-current generators was a severe burden upon the telephone companies, and unless they were well maintained poor service resulted. In fact the magneto telephone may be looked upon as a small power-house in which there are means for generating single-phase alternating current and battery direct current.

One of the greatest difficulties with the old type boards was the lack of supervisory signals for the guidance of the operators. In the larger cities where it was necessary to trunk calls from one office to another, this was particularly exasperating and annoying. The time consumed by the operators on these trunk connections was expensive and premature disconnections were the rule instead of the exception. To overcome these objections the engineers of the American Bell Telephone Co. and the Western Electric Co. developed the modern central battery switchboard. This type of board has become the recognized standard of all the Bell telephone companies.

It is interesting to trace a connection through this type of switchboard. When the subscriber removes his receiver from the hook a tiny incandescent lamp on the face of the switchboard directly over the subscriber's line jack is lighted. The operator inserts into the subscriber's line jack a plug which is attached to a connecting cord. The inserting of this plug automatically extinguishes the subscriber's line lamp. The operator now depresses her listening key which connects her telephone with the subscriber's line and asks for the number wanted. A plug attached to the other end of the connecting cord is inserted into the line jack of the wanted subscriber and the operator depresses a ringing key which sends an alternating current over the line to ring the bell of the called subscriber. However, it should be said that before fully inserting the plug the operator touches lightly the rim of the called subscriber's line jack. If his line is busy the operator hears a click in her ear and will inform the calling subscriber that the line wanted is in use. It only takes a slight effort to plug into the called line after the test is made and the operator would rather do this than report the line in use. Many tests have shown that the operators make few mistakes in reporting busy lines.

When the called subscriber answers his telephone, a small supervisory lamp in connection with the calling cord is extinguished. When the subscribers are through talking and each hangs his receiver on the hook, supervisory lamps wired to the connecting cords are lighted and thus indicate to the operator that the pair of cords, and therefore connected lines, are no longer in use. She

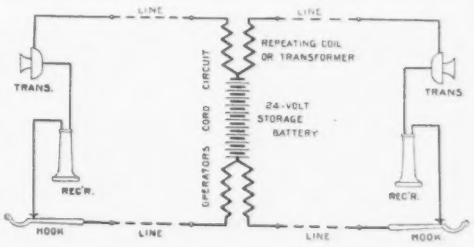


Fig. 2. Simplified Diagram of a Central Battery Telephone System.

will then take down the plugs and both supervisory lamps will be extinguished.

Each operator in a large central battery, multiple exchange has within her reach the line jacks of all subscribers in this exchange. This is accomplished by connecting every subscriber's line to line jacks placed every 5 ft. along the face of the switchboard.

It is thus seen that all trunk connections require the services of two operators, although the trunk operator at the far end of the trunk does not converse at all with the subscriber, and acts only under the instructions and orders of the operator originating the call. When the subscribers who have been conversing over a trunk line are through with their conversation and hang up the receivers, automatic lamp signals are displayed before the operators, which show that the trunk is no longer in use.

Fig. 3. A Section of a Modern Telephone Switchboard.

All the current is supplied to the transmitters from one large central storage battery, as shown in Fig. 2.

A great majority of the people, and in fact many engineers, are unacquainted with the electrical principles of telephony, and do not understand that telephony and electric light and power distribution are similar problems in the transmission of electrical energy. This similarity was clearly brought out a few years ago by Mr. C. P. Steinmetz in an address delivered before the American Institute of Electrical Engineers, in which he said:

The problem of transmitting alternate currents leads to two very distinct phenomena and problems, that of

*Part of a paper presented before the Engineers' Society of Western Pennsylvania, September, 1908.

†General Superintendent of Plant, Central District and Printing Telegraph Co., Pittsburg, Pa.

transmitting very large powers at very low frequency relatively, at high voltages with the so-called electrical power appliances, and then the transmitting of very small powers at very high frequency at very low voltage. That is telephony. The theoretical aspect of the problem is the same, but they have to be considered entirely different.

In the development of the central battery switchboard there were required the creation of many new types of apparatus. Special types of charging dynamos had to be developed which would charge the storage batteries without introducing noises in the thousands of connected telephones. New types of electric transformers known as repeating coils had to be designed which would have a high efficiency for the high frequency currents made use of in telephony. Then, again, many hundreds of different types of relays or circuit closing devices were necessary. In some of the circuits there may be several dozen contacts for the telephone current to pass through. Any one relay falling out of step will interrupt the connection, and yet some of our subscribers on very rare occasions become exasperated with the whole telephone system because one of these many hundreds of relays fails to open its contact at precisely the right moment. And strange to say, the public nearly always blames the operators, never stopping to think that perhaps a portion of the delicate and elaborate electrical mechanism in the line is at fault. In Figs. 3 to 7 are shown types of modern central-battery switchboards in connection with cable entrances, distributing frames, etc.

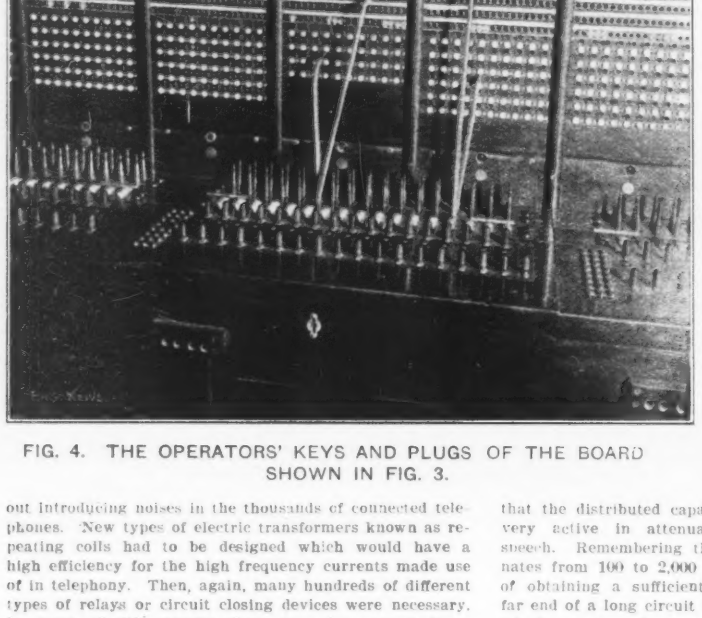


FIG. 4. THE OPERATORS' KEYS AND PLUGS OF THE BOARD SHOWN IN FIG. 3.

In the last eight years there has been great development in the methods of outside construction. In the early days telephone lines were naturally modeled after the existing telegraph construction. The large number of circuits required and the different character of the transmitted current has led to special types of construction for telephone work. In the large cities, in congested centers, underground construction is employed, using cables containing as many as 600 pairs of wires, with direct connection to the subscribers' premises by means of interior-block wiring. This is shown in Fig. 8. Conduits are also built along the main feeder routes to the outside districts, but the distribution is effected at right angles to these feeder routes by neatly designed aerial cables. These cables contain from 50 to 200 pairs of wires and are tapped about every other pole, so that the service wire to the subscriber's premises may be made of a minimum length. This method of connection is shown in Fig. 8. It is interesting to note that one of the first underground systems for the distribution of telephone wires anywhere in the world was installed in 1882 on Fifth Ave., between Wood St. and Liberty Ave., Pittsburg. Perforated porcelain blocks were laid on edge in a wooden box and annunciator wire pulled through the holes, after which the box was filled with pitch. These wires gave service for nearly a year, until the insulation finally failed.

It had been known for some time that even with very powerful transmitters the range of telephone transmission had a distinct limit, and the increasing of the transmitting power had but little effect in increasing the volume or improving the articulation of the transmitted speech. The telephone current has such a high frequency that the distributed capacity in a long telephone line is very active in attenuating and distorting telephone speech. Remembering that the telephone current alternates from 100 to 2,000 times per second, the difficulty of obtaining a sufficient quantity of electricity at the far end of a long circuit to properly operate the receiving telephone apparatus can easily be appreciated. If we had to deal with the resistance of a telephone circuit alone, and the capacity and self-induction were absent, the current received at the far end would be strictly proportional to the resistance of the circuit; but when distributed capacity is combined with resistance and the self-inductance is very small, the waves of current are rapidly attenuated and besides distorted, for the higher frequencies, corresponding to the over-tones of the human voice, will not be attenuated at the same rate as the lower frequencies, and therefore the received speech will appear unintelligible or distorted to the listener.

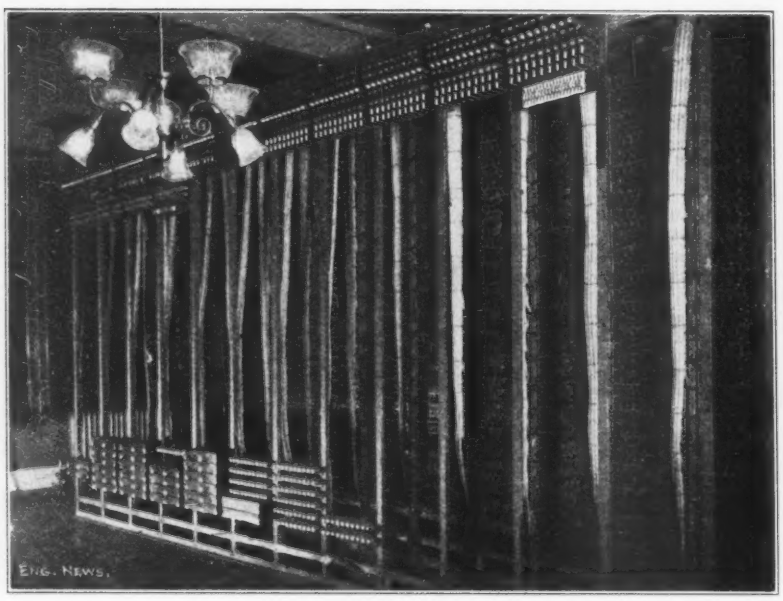
Mathematical studies of electricity had pointed out some years ago that the distributed capacity of a telephone circuit might be counteracted by inductance placed in the circuit, but it remained for Prof. M. I. Pupin, of Columbia University, to show us how to place self-inductance in a telephone circuit so as to limit the effect of the distributed capacity. These self-inductance coils are known as loading coils and are being used to-day in thousands of lines of the Bell telephone companies. The placing of these coils in a telephone circuit will increase the range of good telephone transmission over the circuit from three to five times. This invention has been of the greatest importance to telephony and its value cannot be overestimated. In Fig. 10 is shown the method of connecting a loading coil in a telephone circuit.

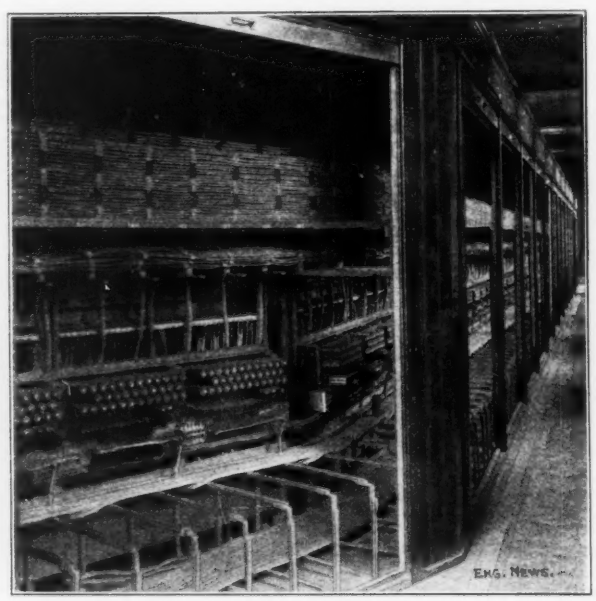
Fig. 7. A Group of Telephone Cables Entering the Distributing Frames.

The telephone repeater is another recent invention which gives great promise and in conjunction with loaded lines may increase the range of transmission of a circuit many times. A few of these repeaters are now in commercial operation.

There have been developed and placed in operation in a few cities so-called automatic telephone switchboards. However, in these systems the subscriber really does his own operating in that he is compelled to do the work of setting up figure combinations and operating keys, which in the manual system is left under the control of a skilled operator. These systems are marvels of mechanical and electrical ingenuity, but it is a serious question to the author if they will ever come into universal use.

The present central battery switchboards are in reality full of automatic features. When a subscriber takes a receiver from the hook a lamp at central automatically lights; when the operator plugs into the line jack this





FIGS. 5 AND 6. DISTRIBUTING FRAMES; CARRYING SUBSCRIBERS' WIRES FROM CABLES TO OPERATORS' BOARDS.

lamp is automatically extinguished; when the called subscriber answers, a lamp on the keyboard shelf is automatically extinguished, and so on, through a multitude of automatic actions. It is probable that the development of telephone switchboards will be in the direction of still further supplying automatic devices to the present type of switchboard, thus increasing the efficiency and speed of the operator without eliminating the human brain from the connection and without causing the subscriber to do his own operating.

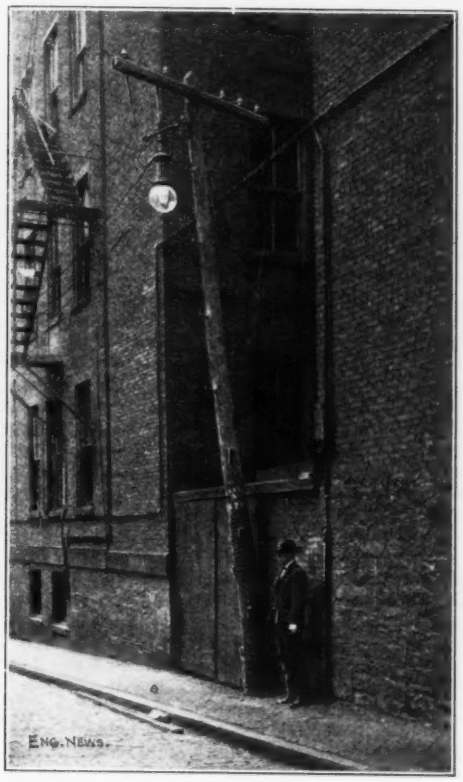


Fig. 8. City Telephone Lines: Subscribers' Wires Rising from Underground Cables.

In bringing to a close this short paper on the development of telephony it is with admiration that I will touch briefly upon the very latest development in the art: wireless telephony.

Fig. 9. Overhead Distribution of Telephone Lines from Overhead Cables.

The best work on wireless telephony has been done, I believe, by Professor R. A. Fessenden, a scientist of whom Pittsburg has reason to be proud. He has developed a dynamo capable of producing electric currents at a frequency of 100,000 cycles per second, and at th's high frequency electrical energy is radiated into space with ease. For the receiving station he has invented the liquid barretter, an instrument which is extremely sensitive to electric waves and which requires no decohering apparatus. The stream of electric waves sent out from the transmitting station is varied by means of a transmitter located in the antennae circuit. The antennae at the receiving station conduct the electric waves through the barretter which changes its resistance in exact proportion to the amplitude of the incoming electric waves. A local circuit containing a battery and an ordinary telephone receiver will therefore reproduce the speech from the transmitting station. It might be added that the frequency of the electric waves is purposely made so high that there is no audible tone in the receiver except in response to the variations in the electric wave energy. It is too early to say what the commercial possibilities of wireless telephony may be, but it is probable that it will supplement instead of supplant wire telephony.

The growth of the telephone system in the United States during the past ten years has scarcely been paralleled in any other line of business. Fig. 11 shows the number of telephones connected to the Bell telephone system each year since 1876. The present number of telephones connected to the Bell system is about 4,000,000; the investment is $550,000,000; the number of miles of wire in use, 10,000,000; the number of telephone connections handled per year, 5,997,000,000.

Even in the face of the depression of the past year, the telephone business has shown steady gains, which clearly brings out the fact that the telephone is now in the necessity instead of the luxury class. It may be called the high-speed tool of the 20th century which is shaping the business and social relations of the world.

Perhaps in time to come the telephone lines of to-day may all be forgotten and the late Prof. Ayrton's picture of the future may be fulfilled:

> The day will come, when we are all forgotten; when copper wires, gutta percha covers and iron bands are only to be found in museums, that a person who wishes to speak to a friend but does not know where he is, will call with an electrical voice which will be heard only by him who has a similarly tuned electric ear. He will cry, "Where are you?" and the answer will sound in his ear, "I am in the depth of a mine, on the summit of the Andes, or on the broad ocean." Or perhaps no voice will reply, and he will know that his friend is dead.

Portland Cement for Use in the Tropics.

By RICHARD K. MEADE.*

Under the title "Portland Cement Testing," there appeared in "The Philippine Journal of Science," of June, 1908, a paper by W. C. Reibling and L. I. Salinger, of the Chemical Laboratory of the Bureau of Science, Manila, P. I. This paper was abstracted very fully in Engineering News of December 3, 1908, p. 612, under the heading, "The Testing of Portland Cement for Use in the Tropics." The conclusions drawn by the authors of this paper are that Portland cement to be used in the tropics, and more particularly in the Philippine Islands, should have a markedly different composition from that used elsewhere.

It seems to the writer unfortunate that this paper should have been so widely circulated or should have come from a government source. The danger of publications issued under the approval of the government is that they will be extensively used by one manufacturer to injure the trade of another and to foster his own interest. In this particular instance we believe that there will be a number of points in the paper on "Portland Cement Testing" which will be very promptly seized upon by the unscrupulous manufacturer to damage the trade of a worthy competitor. The individual government employee at all times has the right to express his opinion, but when he does so over his official position with the government, his utterances assume judicial importance without, as is the case with legal decisions, being subjected to a possible final reversion by a higher court, if found to be in error. That much of the investigating now done by the government is of the highest type of research work and likely to lead to practical results no one will dispute but, at the same time, bulletins and other publications should be carefully reviewed by competent boards or submitted to acknowledged authorities before being allowed to appear as government documents or to be published as "contributed from" government laboratories.

The authors of this paper on "Portland Cement Testing" are, judged simply by their own production, men of very limited experience with and knowledge of the properties of Portland cement, otherwise they would have stated many of their assertions very much less vigorously and very much more reservedly, and some of them not at all, as trite and covering ground already well gone over. Perhaps the first thing that the chemist who investigates cement finds with experience is that conclusions of a positive nature about this very complex substance are very dangerous things to draw, and, as "one swallow does not make a summer," so one series of experiments can not be used to devise a law for the behavior of Portland cement.

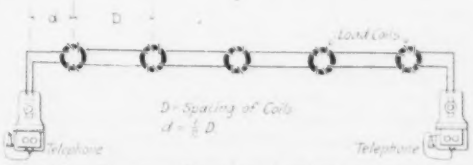


Fig. 10. Diagram Showing Application of Pupin Coils to Telephone Line.

The opening part of this report may be passed over lightly. The discoveries which the authors have made in the first pages are those which any observing embryo cement tester promptly finds out for himself, the effect of the percentage of water used and the influence of temperature upon the rate with which cement hardens, the fact that the lumpy cement will not give as high tests as one free from lumps, the effect of aeration upon the setting time of cement, etc., have all been fully investigated by chemists and engineers of every land.

HIGH ALUMINA CEMENTS. — The part of their report which probably will excite most interest and also do most harm is the attempt to show that a special cement is demanded to withstand the climatic influences of the Philippines. The authors have devoted a large part of their paper to a discussion of high alumina cements, and have attempted to prove by a number of experiments, by references to the publications of other cement investigators, the writer included, and by some deductions of their own of a purely theoretical nature, that cement containing more than 7% alumina is unsuited to use in the tropics. As the present writer has had a wide experience with both high and low alumina cement, and also with cements which became

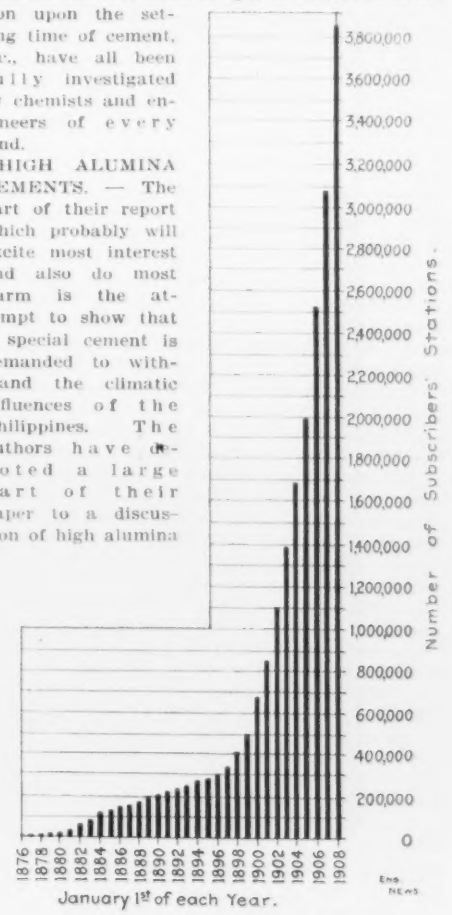


Fig. 11. Diagram Showing Growth of Telephone Business.

*Chemist, Dexter Portland Cement Co., Nazareth, Pa.

quick setting upon storage, his conclusions along this line may be of interest to the readers of Engineering News. These conclusions are based, not upon a few experiments made with one or two brands, but upon a large number of experiments made with a number of brands, and also as the result of the examination of the laboratory records of quite a number of Portland cement manufacturers. This information published at this time may also do something to offset the effect of the publication of the paper mentioned.

It is true that alumina influences to a considerable extent the rapidity of the set of Portland cement. It is, however, not the only component which does this. It is also true that fixed limits in an analysis can seldom be adhered to, because it is not so much a case of the actual percentage of essential elements, silica, lime and alumina present as of their relative proportions and the way in which they are combined with each other. For instance, we have seen high silica cements made from sandy clay and limestone which had the properties of low silica cements. The reason for this was simply that a certain part of the silica never combined with the lime at all to form hydraulic compounds, but remained in the cement merely as inert silica. If we deduct this silica, we find that the actual amount of silica which has gone into solution bears about the same ratio to the lime and the alumina as that in some low silica and high alumina cements. Portland cements which contain high percentage of alumina are *apt* to be quick setting or to become so on aeration. This does not necessarily mean, however, that they *will* be quick setting or that they *will* become so, because there are a number of methods which can be adopted to prevent this. One of them is having in the cement a higher percentage of lime than would be carried in an ordinary cement. While it is true that the combining proportion of silica is greater than that of alumina it is also true that alumina cements are very much more easily burned, and hence it is possible to carry very much more lime in the cement and still burn it thoroughly. A cement which contains a *very* high percentage of alumina would be very hard to burn uniformly because it would burn at a lower temperature and would stick and ring badly in the kiln. This, however, would not apply to cements of average composition. High alumina cements show very much greater early strength and as high ultimate strength as do high silica cements, and they are more apt to be sound.

The greatest objection that has been raised to the high alumina cements is the fact that they do not show a progressive strength when tested neat, that is, their strength when tested neat after 28 days will be very little if any higher than their strength at 7 days. This is a point, however, which should not be considered as against high alumina cements because it enables the contractor, not only to remove his forms promptly, but also in cold weather to carry out construction work which it would be hard to do properly with a slow-setting cement, owing to the difficulty of keeping the concrete from freezing when used in floors and thin partitions. There seems to be no good reason either why a cement should be expected to show a progressive gain. A railroad company would not consider a steel rail any the better for the fact that it had a low strength when it was put in the track and a high strength 28 days thereafter. They would much prefer it to have a high strength when they laid it. The same reason holds perfectly good for concrete, and as long as the cement does not retrogress there is every reason why the cement which gets its full strength soonest should be the one to have the preference. Strange as it may seem, however, this most common objection to high alumina cements was not raised in the paper of Messrs. Reibling and Salinger, and they confine themselves almost entirely to the effect of high alumina upon the setting time. They even go so far as to state that high alumina cements have one laudable feature in that they are perfectly sound (a good recommendation if true), and that perfect soundness is essential in the Philippines.

Perhaps no property of Portland cement is so changeable or for that matter so hard to test as the setting time. The present writer's experience has been that even a very experienced cement tester, when working with the Gilmore needle, seldom gets pats made up on different days and practically under the same condition to agree in setting time, and this difference sometimes has amounted to as much as from 30 to 60 minutes. This is not altogether caused by any change which has taken place in the setting time of the cement, but rather to the fact that very minute variations in the percentage of water, time of working, and temperature of the air, etc., will often affect the setting time considerably.

It is a well known fact to those who have worked with cements containing between 6½ and 8½% alumina that these cements when of certain composition will on exposure to air become quick setting. A bin of such cement freshly ground may have a setting time of three or four hours, and after three or four days a sample drawn from this bin itself may show a setting time of only a few minutes. It sometimes happens that another sample drawn a week later will again be slow setting, and still another sample drawn still later will be again quick setting. This changeable set is not altogether due to heat and humidity, although it is much more apt to occur in warm weather than in cold, but it does occur in cement ground in mid-winter if the same has not been properly proportioned.

A large number of engineers are familiar with the term "hydraulic index," as applied to cements. It is not very definite, but usually means the relation between the lime on the one hand and the silica and alumina on the other, or expressed as a fraction:

$$\text{Hydraulic Index} = \frac{\%\ \text{Silica} \times \%\ \text{Alumina}}{\%\ \text{Lime}}$$

This formula has to some extent been superseded by that of Newbery and that of Le Chatelier. The writer's experience, however, has been that the old hydraulic index is as near an expression of the proper composition of cement as we can get with our present knowledge of the chemical structure of this complex solid solution. This belief has been strengthened of late years by the work of Messrs. Day and Shepherd of the Carnegie Institute, who have found that the compounds prepared by Newbery and Le Chatelier and used by them as the basis of their formulas are non-existant and that what these experimenters believed to be tri-calcium silicate was nothing more than a solution of lime in ortho-silicate. Any formula, therefore, which endeavors to give in mathematical terms the proper composition of cement would probably merely set the percentage of lime dissolved in the magma, as for example, a 15% solution of lime, so that for the purpose of this discussion we can go back to our old "hydraulic index."

While it is true as has been stated that silica combines with a greater proportion of lime than does alumina, it is also true that alumina makes a more fusible clinker and one which will hold in solution a large amount of lime. This is shown by the fact that so far as practical composition goes, the high silica cements contain no more lime than do low silica ones. (See Table I.) Nor has it been the writer's experience with these cements that it was possible in them to carry a higher percentage of lime than was possible with the low silica and high alumina ones.

Returning to our hydraulic index we find certain marked properties go with it. The lower the hydraulic index the more strength the cement will have. On the other hand if a certain limit is passed, the cement will be unsound. This limit depends upon a number of manufacturing conditions, such as the fineness to which the raw materials are ground, the degree of burning, and the amount of seasoning which the cement can be given before its shipment. The highest testing American cements are cements with low hydraulic indexes. The higher the hydraulic index the less strength the cement will have. As the hydraulic index increases we notice with high alumina cements a tendency for them to be quick setting or to become so upon storage. As an example of this, with one of the leading brands on the market, tests of more than 100,000 barrels show that all the slow-setting cement had a hydraulic index below 0.47 and that all cement which either was quick when manufactured or became quick on storage had a hydraulic index above 0.47.

There is another ratio besides the hydraulic index, which affects the properties of cement to a marked degree. This ratio the author has always called the "index of activity" and is the ratio between the silica and the alumina or expressed as a fraction:

$$\frac{\%\ \text{Silica}}{\%\ \text{Alumina}} = \text{Index of Activity.}$$

In most American cements this index is above 2½ and in some cases is as high as 4½. When below 3 there is possibly a tendency for the cement to show the quick setting properties which we have mentioned. At the same time, there are practically very few American cements which rise above 3, and the vast majority of them lie between 2.5 and 2.75, with occasionally here and there one as low as 2.4.

These two indexes do to some extent control the properties of cement, but they are not sufficient alone for even the most experienced cement chemist to predict the properties of a cement. Manufacturing conditions will also play an important part in this. The percentage of iron and of magnesia must affect the properties, if in no other way by influencing the combination of one element with the other. Unless magnesia is present as an oxide, it must take the place of a certain amount of lime in combination with silica, unless iron too is present as an oxide, it must take the place of a certain amount of alumina in combination with the lime, etc. There does seem to be this fact, however, fairly well established that there is a certain relation between the "hydraulic index," the "index of activity" and the setting time of cements. With cements having a low index of activity the setting time can usually be increased by lowering the hydraulic index. Cements with a high index of activity can often have a very high hydraulic index and still be slow setting, while a cement with a low index of activity and a high hydraulic index will set rapidly. At the same time at one mill, the chemist may carry his hydraulic index and index of activity at the same figure as his neighbor and yet have trouble with the setting time of his cement which his neighbor never has, due to manufacturing conditions. As an illustration, with small experimental kilns burning the same mixture as the large ones the resulting cement is often quick setting from the former and normal from the latter, etc.

In Table II. are a few examples showing the relation between the indexes, etc. Nos. 1, 2 and 3 are samples of the same brand of cement. No. 1 became quick setting after seasoning one month in a small paper bag, although it had practically the same index of activity as No. 2 and a much higher index than No. 3. No. 2 and No. 3 both have normal set even after one month's such seasoning. No. 1 has a high hy-

TABLE I.—ANALYSES OF REPRESENTATIVE AMERICAN CEMENTS.

	Where made.	Made from.	Silica.	Iron oxide.	Alumina.	Lime.	Magnesia.	Sulphur trioxide.
1	New Jersey	Cement Rock and Limestone.	21.82	2.51	8.03	62.19	2.17	1.02
2	Pennsylvania		22.20	2.27	6.69	62.61	3.00	1.56
3	Pennsylvania		20.32	2.58	7.30	63.93	2.57	1.27
4	Virginia	Limestone and Clay.	21.31	2.81	6.54	63.01	2.71	1.42
5	Michigan		20.74	2.85	7.17	62.64	1.97	1.42
6	California		25.38	1.20	3.34	62.96	1.20	0.35
7	Mexico		20.16	2.05	6.33	63.27	3.04	1.80
8	Alabama		20.54	3.84	8.55	63.85	0.00	...
9	Michigan	Marl and Clay.	21.12	3.59	7.55	63.35	0.81	1.59
10	Ohio		21.41	2.15	6.88	62.72	1.44	1.57

TABLE II.—ANALYSES OF QUICK AND SLOW SETTING CEMENTS.

No.	Silica.	Alumina.	Index of Activity.	Iron Oxide.	Lime.	Hydraulic Index.	Magnesia.	Sulphur trioxide.
1*	20.76	8.12	2.56	2.20	60.66	0.48	3.10	1.55
2	20.30	7.80	2.60	2.18	62.99	0.45	3.16	1.55
3	19.92	8.32	2.40	2.22	63.41	0.45	2.70	1.40
4	19.52	7.50	2.60	2.80	62.31	0.43	3.05	1.61
5*	22.02	7.44	2.96	2.28	61.71	0.48	2.88	1.56
6	23.18	8.44	2.75	1.02	63.66	0.50	1.40	1.52
7*	24.12	5.44	4.43	3.22	60.50	0.49	2.46	1.84
8	22.90	5.24	4.37	3.14	62.74	0.45	2.58	1.65
9*	19.92	6.94	2.87	3.48	61.72	0.43	3.44	1.68
10	20.18	7.22	2.80	3.35	61.27	0.45	3.36	1.62

*These cements became quick setting on seasoning in the laboratory one month or less.

draulic index, Nos. 2 and 3 have low hydraulic indexes. Similarly No. 4 and No. 5 are average samples of two lots of several thousand barrels of cement from different works. No. 4 had a normal set after a month's seasoning, No. 5 became quick setting in this time. No. 5 has less alumina and more silica than No. 4, but the latter has a much lower hydraulic index, which explains the difference in behavior. No. 6 has more alumina than any cement in the table. Its index of activity, however, is high and the small percentage of iron no doubt permits of the high hydraulic index. At the end of a month it still had a normal setting time. No. 7 is an example of a low alumina cement which became quick setting on seasoning, while No. 8 did not do so. Again it is probably a case of hydraulic index. No. 9 has the same hydraulic index as No. 10, and is from the same mill. No. 9 became quick setting after a few weeks seasoning, while several month's storage in a small paper bag in the laboratory had no effect upon No. 10. No. 9 was made from coarsely ground raw material and was unsound when fresh but seasoned sound. Considerable (3.60%) silica separated out on solution in acid, showing free silica in the cement. If we deduct this silica from the total and calculate the ratio between the remainder and the alumina we find an index of activity of only 2.35. The above show the difficulty of predicting from the percentage of alumina only, just what properties a cement will have.

Returning now to the paper by Messrs. Reibling and Salinger, we find that only one of the cements which became quick setting contained sufficient sulphur trioxide (SO_3), or as it is commonly called, sulphuric acid. Probably the first comment which an experienced cement chemist, or even one familiar with the usual composition of Portland cement, would make upon seeing the analyses given in Table VII. of their paper and also those in Table XXVI. (see Table III. of

TABLE III.—ANALYSES OF CEMENTS TESTED BY MESSRS. REIBLING AND SALINGER. (Table XXVI of their paper.)

No.	Silica.	Iron Ox.	Alumina.	Lime.	Magnesia.	Sulphur trioxide.	Loss on ignition.	Hydraulic Index.	Index of Activity.
1	20.65	3.07	8.57	61.83	2.26	0.51	2.47	0.47	2.41
2	20.70	3.01	8.42	61.60	1.94	0.59	2.76	0.47	2.42
3	22.00	3.0	8.9	59.9	1.55	...	5.3	0.52	2.48
4	20.52	2.65	8.71	61.30	1.96	0.46	4.33	0.48	2.36
5	21.28	2.29	6.95	61.08	0.21	1.17	6.36	0.46	3.06

the present article) would be that the cement had not had added to it enough gypsum or plaster of paris. It is hardly necessary here to do more than call attention to the fact that Portland cement clinker if ground fresh from the rotary kiln without any addition whatever would set too quickly for ordinary use. It has, therefore, been found necessary to add to this plaster of paris in order to delay the set of the cement sufficiently to allow of its being properly worked. Practically all American cements and most of the foreign ones contain between 1 and 1.75% sulphur trioxide. Of the cements whose analyses are given by Messrs. Reibling and Salinger only one, No. 5, contained sufficient sulphuric acid, and this cement did not become quick setting until after it had been exposed to the air for "such a very long time" that it had united with 6.36% water and carbon dioxide.

Studying the analyses (see Table III.) also in the light of the information given above as to the effect of the index of activity and hydraulic index upon the properties of cement we see that these cements, with one exception, have fairly high hydraulic indexes for high alumina cements, and that the only one of them which has a low hydraulic index, is the cement (No. 5) above referred to, so that it really narrows down to the point that of all the cements upon which they based their conclusions as to alumina it is possible that only one was of normal composition. The other four cements whose analyses are given do not contain sufficient sulphuric acid to give them the proper setting time under any and all conditions, and also a lower hydraulic index would improve, unquestionably, this setting time after seasoning.

The error made by these chemists in attempting to draw conclusions relative to composition from such a series of experiments is shown more conclusively to the engineer perhaps by Tables IV. and V., herewith shown. The first is taken from the author's note-book and shows the analysis of five recognized leading brands of Portland cement from the Lehigh district. The second table is taken from the mineral resources of the United States for 1904, and gives the characteristic analysis of American Portland cements. The five analyses given in Table IV. are

TABLE IV.—ANALYSES OF LEHIGH VALLEY CEMENTS.

No.	Silica.	Iron ox.	Alumina.	Lime.	Magnesia.	Sulphur trioxide.
1	19.52	2.80	7.50	62.31	3.05	1.61
2	21.82	2.51	8.03	62.19	2.71	1.02
3	20.76	2.20	8.12	62.80	3.06	1.55
4	20.32	2.18	7.80	62.99	3.16	1.45
5	20.02	2.28	7.64	62.31	2.88	1.56
6	21.14	2.14	7.10	62.64	1.97	1.42

all those of cements which have a reputation among engineers and architects for their uniformity of set, strength, and general good properties. It will be seen that not one of them will pass the specifications for chemical composition drawn up by Messrs. Reibling and Salinger. The brand of cement of which No. 5 is a representative analysis never contains less than 7% alumina. From 20,000 to 50,000 bbls. of this brand are shipped every year to Central and South America, to Cuba, Porto Rico, and Mexico. Of all this quantity of cement, we know of not one instance where a complaint was made that the cement set other than normally. Practically all of these cements, in fact, have been exported largely. Cement No. 3, of which the analysis is probably slightly higher in alumina than it will generally show, is used almost exclusively for sidewalks and ornamental concrete work, and its popularity along this line lies almost entirely in the fact that its setting qualities are very uniform, even in hot humid summer weather.

It will be seen from Table V. that the average alumina in American Portland cements is about 7½ per cent. The average setting time reported by the St. Louis laboratory upon all this cement was 145 minutes (or 2¼ hours), and strange to say the slowest setting time, 260 minutes (or 4½ hours) was obtained on the limestone and blast furnace slag cement, containing 8¼% alumina. The conditions of use were such that if the cement had developed quick setting properties, this latter would have been detected.

Table VI. shows the analysis of six foreign brands which have been shipped to almost all parts of the world, and all climates. The first two German cements are famous export brands and we have never heard of their becoming quick setting in the tropics; in fact, one of the strongest claims made for these German cements is their uniformity and regularity of setting time.

The paper in question tells us among other things that the difference between the local climate of Manila and that of temperate climates exerts very little influence upon the usual standard tests themselves. It is, therefore, very safe to estimate that cement which gives proper tests in this country will also give proper tests in the tropics. We are also told that in general the temperature is conducive to slightly better results, that the soundness tests are benefited "as the cement does not suffer as great a change in temperature, and hence expansion and warping is not so much marked." Considering the fact that the maximum temperature in the Philippines is hardly more than 100° F., while the temperature of boiling water is 212° and the temperature in this country on a warm day is sometimes 93° and 94°, the present writer is somewhat skeptical of this beneficial effect. We are also told that "climatic conditions improve the characteristics of early tensile strength of most cements, as the variation in temperature from day to day and from hour to hour is only slight, the temperature of the water bath is higher than in cold climates, and the temperature during gaging is also higher." This we can readily understand and believe would be conducive to good early tensile strength tests. We are also told that the relatively higher temperature of this climate will seriously affect the setting qualities of some cements. This, of course, is nothing more than has been observed in this country that cement tested in the warm laboratory very often sets rapidly and yet can be used for work in early fall without showing any inconvenient properties along this line. The authors, however, tell us that Portland cement is most affected by local climatic conditions *before* and not *after* it is gaged,

high temperature and the alternating humid dry atmosphere are conditions under which hydration and carbonization are accelerated. In consequence the majority of commercial products must be especially prepared to withstand tropical climates. Portland cement is very susceptible to changes under these conditions, and it is therefore essential to the best practice that cement for use in the tropics should develop no dangerous properties by the absorption of water and carbonic acid in normal quantities. The cement problem of tropical countries depends for its solution upon the characteristics of Portland cement; and our efforts have been to determine what class of cements are most affected by exposure and seasoning.

Unfortunately the authors did not carry out this program but endeavored to determine from tests made of one brand of cement; or certainly of one class of cements, since all of their analyses show very much the same characteristics, what cement was best suited to tropical conditions. We must confess that we can hardly see how cement can absorb any more water because of an alternately dry and humid atmosphere than it will in a humid one. Messrs. Reibling and Salinger's own analyses do not indicate that this is the case. Let us take their cement No. 8. This they divided into two samples, one of which they placed in a tin can and

TABLE VI.—ANALYSES OF "EXPORT" BRANDS OF FOREIGN CEMENTS.

Brand.	Silica.	Iron ox.	Alumina.	Lime.	Magnesia.	Sulphur trioxide.
Alsen, German	20.48	3.88	7.28	64.03	1.76	2.46
Dyckerhoff, German	20.64	3.69	7.15	63.06	2.33	1.39
Lagerdorfer, German	23.55	2.40	7.47	61.99	1.42	1.07
Josson, Belgian	22.92	2.46	7.98	63.39	trace	1.28
Candlot, France	22.30	3.50	8.50	62.80	0.45	0.70
K. B. & S.	19.75	5.01	7.48	61.39	1.28	0.96

one in a paper bag. The sample in the tin can of course absorbed practically no water and carbon dioxide, that in the bag took up some and became quick setting. The difference between the two amounted to 0.92%. Samples of cement exposed in paper bags in the present writer's laboratory, for various lengths of time absorbed water and carbon dioxide as follows:

Fresh	.....	total 1.86
After 7 days,	increase 1.10%,	total 2.96
After 14 days,	increase 1.42%,	total 3.28
After 21 days,	increase 1.72%,	total 3.58

This is much more in seven days than Messrs. Reibling and Salinger's cement had absorbed after eleven days. When fresh from the mills it had a setting time of 2 hours and 5 minutes.

TABLE V.—AVERAGE CHARACTERISTIC ANALYSES OF AMERICAN PORTLAND CEMENTS.

Made from.	Silica.	Iron ox.	Alumina.	Lime.	Magnesia.	Sulphur trioxide.
Limestone and cement rock	22.07	2.50	7.51	62.82	2.58	1.51
Limestone and clay or shale	22.18	3.49	7.31	62.80	1.62	1.39
Limestone and slag	23.62	2.71	8.21	61.92	1.78	1.62
Marl and clay or shale	22.36	2.68	6.93	63.37	1.99	1.33
Average	22.56	2.85	7.49	62.73	1.99	1.46

and at the end of 21 days of 1 hour and 45 minutes. This is about the normal rate of absorption in this section of the United States (Eastern Pennsylvania) for the fall of the year and for Lehigh Valley cements. Finely ground cements will absorb more water than coarsely ground ones, and more water will be absorbed in warm than in cold weather. Analyses of their sample No. 8 and of the Lehigh valley cement above referred to are given below:

	R. & S. No. 8.	Lehigh Valley.
Silica	19.80	20.05
Alumina	8.33	7.32
Iron oxide	2.75	2.20
Lime	62.44	61.20
Magnesia	2.25	3.09
Moisture	0.32	0.40
Loss on ignition	3.14	3.18
Sulphuric acid	0.43	1.49
Hydraulic Index	0.45	0.45
Index of activity	2.38	2.74

As the hydraulic index of the first of these cements is low (0.45) it seems probable that if it had contained as much sulphur trioxide as the second its setting properties would be all that could be desired and it also seems probable that an addition of sufficient plaster of paris to the sample to bring the percentage of sulphuric acid up to that of the Lehigh Valley cement would also slow its set and permit of its being used.

It may also be of interest to note here that those cements which set rapidly may often have their set slowed by the addition of quick lime to the water used to gage the cement or else hydrated lime to the cement itself. When cement becomes quick setting from exposure to the atmosphere it would therefore seem to be a much better practice to slow the set of the material by addition of a little hydrated lime to the cement or by dropping a few lumps of lime in the barrel of water used for gaging rather than to condemn the cement.

AERATION.—This brings us to another point. Has any one a right to set a small sample in the warm and usually moist air of a laboratory and because the sample after such storage for a month becomes quick setting condemn a carload of cement in a warehouse as likely to develop dangerous properties? If cement will aerate enough in a day to develop quick setting properties, it probably would be cause for grave concern. If the sample takes a week or more it is certainly safe to assume that the main body of the cement will not develop any such properties unless kept for a very long period. The surface exposure of a sample of cement in a small paper bag is so enormously out of proportion to that of cement in cloth bags piled in a warehouse, that the two hardly have any relation to each other. For instance, it frequently happens that a sample of unsound cement left in the laboratory a few days will pass the boiling test, while the stock from which it is drawn may lay in the warehouse for as many months before a new sample freshly tested will do so.

Laboratory tests of material after all have considerable limitation, to which the engineer and chemical engineer who have put in practice the result of such "research work" can usually testify most strongly. The only laboratory research work which is likely to prove of value is that in which laboratory and working conditions are kept very close together. If the engineer desires to investigate the relation between the setting time of a cement and its aeration, let him keep a 95-lb. bag of cement and draw samples from all parts of this bag (not simply from the top surface) and mix them.

CHEMICAL ANALYSES.—At the present time one of the most serious drawbacks to chemical specifications for cement is the question of the accuracy of chemical analyses. Recently three of the most prominent chemists in the country were asked to report upon some thirty samples of cement. These men are all of them experts in cement analysis, yet the average alumina determinations of the three upon the 30 samples were as follows:

$$A = 6.88\%.$$
$$B = 7.56\%.$$
$$C = 8.56\%.$$

The samples according to *A* will pass Messrs. Reibling and Salinger's specifications, while according to *B* they contain ½% and according to *C* 1½% more alumina than is permitted. Let us suppose that *A*, *B*, and *C* were the chemists of three cement manufacturers. *A* would send his cement to the Philippine Islands and believe it to be all right, *B* and *C* might be deterred by Messrs. Reibling and Salinger's investigation from doing so. Let us also suppose *A*, *B* and *C* were chemists at Manila, and that specifications limiting alumina to 7% were adopted, then *A* would accept the cement and *B* and *C* would not, etc.

SPECIFIC GRAVITY AND UNDER-BURNING.—The authors of this bulletin also recommend that the specific gravity tests be taken as an indication of under-burning. This seems to be a step backward. The American Society for Testing Materials so far recognized the fact that this test was valueless for this purpose that they struck this clause ("or under-burning") out of their specifications. The authors seem to think that under-burning and excess of lime are the sole causes of the failure of cement to pass the soundness test, whereas, as a matter of fact, probably 90% of the cement which fails on this test fails because the raw materials have not been finely enough ground. For instance, they state that "unsoundness in conjunction with low specific gravity proves that under-burning alone is the cause of the warping and disintegrating." As a matter of fact, unsoundness and low specific gravity would be much more apt to indicate coarse ground raw materials. An under-burned cement would season much more rapidly than one unsound because the raw materials had been coarsely ground, and hence the chances are that, while under-burned cement might show low specific gravity, it would be sound, whereas a cement which had been very well burned but which had been made from coarse raw materials might take up just as much water if given a longer time, have its specific gravity reduced to the same point, and be unsound.

It is rather amusing to the cement manufacturer to hear this "under-burning" and "over-burning" question discussed. The present writer is willing to confess that he has never seen an over-burned Portland cement from a rotary kiln, and that some samples which were fused to a viscous glass in the electric furnace still had excellent hydraulic properties. He is inclined to think that the rate of cooling, etc., would have a great deal more to do with the properties of cement than the temperature at which it was burned, provided this temperature had been carried sufficiently high to bring the lime into solution

The question of specific gravity seems to be one which could be waived in the Philippine Islands very much better than almost anywhere else. The cement has withstood a long sea voyage, and it is probable that it had been lying in the stock house of the manufacturer for at least sufficient time to be tested, since no careful and reputable manufacturer would care to send cement this distance about which he was not perfectly sure. It would therefore seem that low specific gravity in cement which had been exported to the Philippines and tested there would be absolutely valueless as indicating anything. While it is probably perfectly true that the under-burned cement would absorb moisture faster than a well burned one, it is also equally true that a well burned cement does not have to be so very old to take up sufficient water to put itself below the requirements of the American specifications, and it is also true that in the time it takes a shipment or consignment of cement to go from this country to the Philippines, the cargo might very readily absorb enough moisture to lower its specific gravity below specifications.

The authors of the bulletin also err in their statement that all under-burned cements usually show a low specific gravity because of the carbonic acid (or carbon dioxide) which remains from imperfect burning of the raw material. Cement clinker which shows barely any indication of clinkering, and which is hardly anything more than a yellow ball which can be crushed between the fingers sometimes proves to contain as low as ¼% of carbon dioxide. The carbon dioxide which is contained in ordinary cement is almost all of it absorbed during the grinding. In fact it is almost an impossibility to grind a sample under even laboratory conditions which does not take up some of these constituents from the air.

While it is perfectly true that a sample cannot take up moisture beyond a certain percentage without having some of its active compounds saturated thereby, it is also true that one cement might have a considerable percentage of its active compounds saturated and still be better than another cement. For instance, a cement containing 63% lime might have 4 or 5% of this lime saturated and still contain more active cementing matter than one with a very much higher hydraulic index which contained say 60% lime. So it is not, strictly speaking, proper to say that because a cement has taken up 3% moisture it should be rejected because its good properties have been impaired. While it is possibly true that some active compounds are destroyed it is also equally true that if the cement under this condition passes satisfactorily the average requirements the consumer is getting all that he has expected, or generally paid for. It is also true that in almost every case the compounds first hydrated or carbonated are those which cause unsoundness. It is also true that only that portion of the lime which is carbonated is destroyed, as hydrated lime is by no means an inert compound but has good effect upon hydraulic cements and may be made to replace cement in mortars, often to positive advantage and particularly to improve troweling properties.

To sum up, if the Philippine engineers want good Portland cement, or at least an open market to all good cements, they will let the manufacturer decide on the composition of the product (his chemist is usually very much better posted on the effect of composition and aeration on the setting properties of his brand than is an outsider), and confine his energies to securing a finely ground cement, of good strength, and perfectly sound. Owing to the long voyage and delays in transit from this country to the Philippines, low specific gravity found in cements after arrival there is more likely to be due to aeration than to any other cause. It is seldom due to under-burning, and when it is the latter will be shown by the cement being unsound or, if seasoned sound, by low tensile strength. Reputable manufacturers do not adulterate cement, and the irresponsible ones know how to get around the specific gravity requirements.

THE REGULATION OF THE DISCHARGE OF SEWage into the waters of New York State is proposed by a bill framed by the New York State Department of Health. Some of the more important clauses of the proposed law, as given in the Bulletin of the New York State Department of Health for February, 1900, are as follows:

Whenever the State Commissioner of Health shall determine upon investigation that sewage, from any city, village, town, building, steamboat, other vessel or property, is being discharged into any of the waters of the state, which shall include all streams and springs and all bodies of surface and ground water, whether natural or artificial, within or upon the boundaries of the state; and that such discharge is polluting such waters in a manner injurious to health or comfort, he may issue an order directing that within a specified period thereafter such discharge be discontinued and that such proper method of disposal of such sewage be adopted to permanently obviate further pollution of said waters by the municipality, corporation or person responsible therefor as shall be approved by the said Commissioner.

Such order shall not be valid until approved by the Governor and the Attorney General, and when so approved it shall be the duty of the Attorney General to require its enforcement. Such means or methods of sewage disposal must be completed and put in operation within the time fixed in the order.

For the purposes of this act, sewage shall be defined as any substance, solid or liquid, that contains any of the waste products or excrementitious or other wastes or washings from the bodies of human beings or animals. This section shall not apply to refuse or waste matter from shops, factories, mills or industrial establishments not containing sewage as above defined.

Whenever the State Commissioner of Health finds upon investigation that any sewage disposal plant in the state is not producing an effluent as pure as might reasonably be required from such plant and as appears to him to be necessary, he may issue an order to the officer, board or department of any city or village, or corporation or person having charge of or owning such plant, to so operate the said plant as to secure an effluent that is satisfactory to the said State Commissioner of Health.

Grade and Line Revision, and a Concrete Voussoir Arch Bridge; Cumberland Valley Ry

An improvement is now being made on the Cumberland Valley Ry. which has for its object the elimination of a pusher grade, as well as the reduction of both grades and curvature, and which includes the construction of a concrete voussoir arch bridge of 100 ft. span. The entire work is being carried on by the engineering department of the railway. Mr. Thomas J. Brereton, Assoc. M. Am. Soc. C. E., is Chief Engineer, and we are indebted to him for information. Mr. Crosby Tappan is the engineer directly in charge of the work.

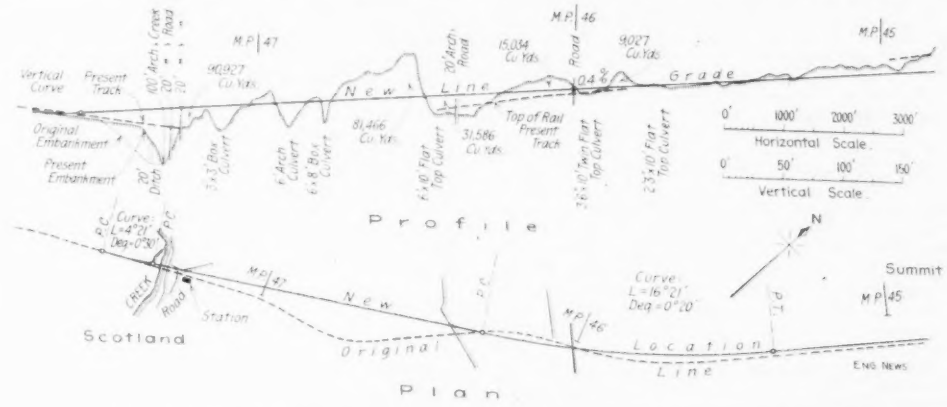


FIG. 1. PLAN AND PROFILE OF THE IMPROVEMENT OF THE CUMBERLAND VALLEY RY. NEAR SCOTLAND, PA.

The distance from Chambersburg, Pa., to Shippensburg is about 11 miles. In this distance, the divide between the Potomac and Susquehanna rivers is crossed at a point about 7.5 miles east of Chambersburg, and at an elevation of 780 ft. above sea level. A minor summit intervenes at a point about four miles east of Chambersburg, the grade descending from that point to the Conococheague Creek at Scotland, about five miles east of Chambersburg. From this point to the summit the grade ascends at the rate of 0.85%.

The revision of the portion of the line from Chambersburg to the summit is being undertaken in order to avoid the necessity for pusher engines. It contemplates the reduction of the grade to 0.4%, the elimination of considerable curvature, and the elimination of the minor summit above mentioned.

Two curves on the revision east of Chambersburg, have a rate of 0° 20′ for a total of 24° 56′, and these replace seven curves of 1°, 2° and 3° for a total of 106° 51′. Through the town of Chambersburg, property has been acquired for revising the line at some later date and elevating the tracks to cross above all streets. On this part of the revision, two curves of 0° 40′ and 4° 18′ (for a total of 64° 53′), will be replaced with one curve of 0° 36′ for 41° 10′.

The part of the revision now in progress is from Scotland, five miles east of Chambersburg, to the summit, a distance of 2.5 miles. A plan and profile of this are shown in Fig. 1. The work, consisting of about 112,000 cu. yds. of excavation (about 75% solid rock) and 140,000 cu. yds. of embankment, has been done by company forces. The largest cut, however, of about 60,000 cu. yds., has been let to C. A. Sims & Co., of Philadelphia, Pa.

The masonry bridges and culverts are entirely of concrete, plain or reinforced. They comprise one elliptical arch of 100 ft. span (for three tracks) over the Conococheague Creek at Scotland; three segmental arches of 20 ft. 8 ins. span over public roads, one arch culvert of 20 ft. 8 ins. span over a stream, and six culverts of smaller size. The 20-ft. arches were all built upon the same centers and lagging, which reduced the expense considerably. All of the masonry, amounting to about 9,000 cu. yds., has been done by the company forces at a cost of about $7 per cu. yd. This includes freight on all material except sand and lumber. The stone was taken from the excavation and crushed on the site. All exposed concrete surfaces are finished by bush hammering. Portable tools operated by compressed air were used for this work in the case of the 100-ft. arch, but on the other structures the work was done by hand. In many cases, regular timber forms were omitted for back walls, old ties being used instead to confine the concrete until set. The view of the 100-ft. arch, Fig. 2, shows the method of securing the timber forms for all face work.

THE CONCRETE VOUSSOIR ARCH BRIDGE.—The most important structure is the arch bridge of 100 ft. span, crossing the Conococheague Creek. The arch ring was constructed in voussoirs in such a manner as to keep the centering symmetrically loaded, the key section being put in last. The curve of stress is so arranged that under no condition of loading will there be any tensile stresses set up, while sufficient reinforcement is introduced to take care of temperature stresses. After the falsework was entirely loaded the settlement at the crown was too small to be determined. The completed bridge is shown in Fig. 2, and the details of its design are shown in Fig. 3.

The bridge carries three tracks. A 20-ft. roadway arch runs through the approach on one side; on the other side, the abtument pier is very similar to the pier between the two arches. The centers for the 100-ft. arch were supported on nine rows of piles 10 ft. apart, the piles being 3 ft. apart c. to c. In Fig. 2, the wedges for the upper part of the centering may be seen above the line of horizontal timbers.

The foundations were carried down to solid limestone rock at a depth of from 8 to 14 ft. below the level of the stream. After rock was encountered, drill holes were put down 8 ft. further, in order to make sure that the foundation was the bed rock and not merely an overhanging ledge, a condition sometimes encountered in the geological formation of that district.

FIG. 2. CONCRETE VOUSSOIR ARCH BRIDGE OF 100 FT. SPAN OVER THE CONOCOCHEAGUE CREEK; CUMBERLAND VALLEY RY.

The Development of the Illinois Experiment Station.*

By L. P. BRECKENRIDGE,† M. Am. Soc. M. E.

The Engineering Experiment Station of the University of Illinois was established by action of the Board of Trustees, December 8, 1903, in connection with the College of Engineering.

There were two influences which led to its establishment; first, a continual demand from the industrial interests of the state for scientific experimentation relating to manufacturing processes, fuel economies and transportation problems; secondly, the very great success attending the work of the Agricultural Experiment Station at the University, which made it evident that a similarly successful career ought to be possible for an engineering experiment station.

The control of the Engineering Experiment Station is vested in the heads of the several departments of the College of Engineering. These constitute the Station Staff and, with the Director, determine the character of the investigations to be undertaken. The investigations are carried on by the staff directly, by Fellows as graduate work, by members of the instructional force of the college, and by special investigators in the station corps.

PLAN AND SCOPE.—It is the purpose of the Station to carry on investigations along various lines of engineering, and to make studies of problems of importance to professional engineers and to the manufacturing, mining, railway, constructional and industrial interests of the State. It is believed that this will result in valuable contributions to science and industry and that the pursuit of such investigations will give inspiration to students and add to the value of their work in the College of Engineering.

REPORTS.—The results of the investigations made are published in bulletins which record mostly the experiments of the Station's own staff of investigators. There are also issued, from time to time, circulars and compilations giving the results of the experiments of engineers, industrial works, technical institutions and governmental testing departments. The bulletins of the Station are distributed among the engineers and manufacturing interests of the state of Illinois, to libraries and the technical press of the country and to such special organizations as are particularly interested in the subject matter discussed by individual bulletins. Already 25 have been published and from 5,000 to 20,000 copies of each have been distributed.

FUNDS ANNUALLY AVAILABLE.—In carrying on the activities of the Engineering Experiment Station, there is necessary a large amount of equipment of various kinds suitable for investigational purposes. The regular equipment provided for instruction in the Col-

*Parts of an address before the Illinois Fuel Conference, March 11, Urbana, Ill.

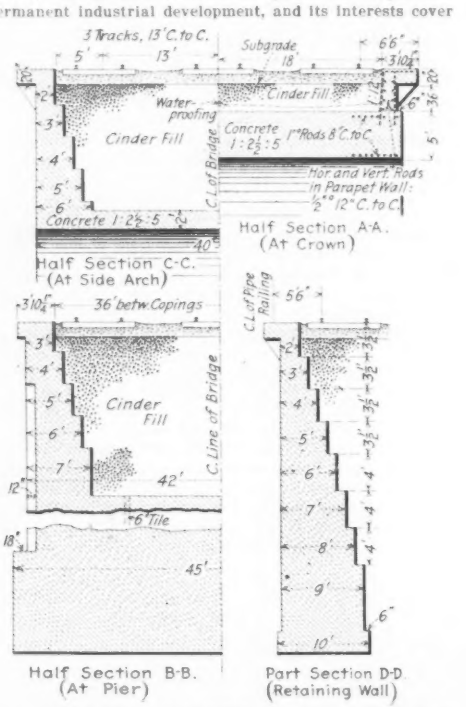
†Director of the Engineering Experiment Station of the University of Illinois, Urbana, Ill.

lege of Engineering has always been used for these investigations, supplemented by the purchase of special apparatus necessary for special researches in the Engineering Experiment Station. After an investigation has been concluded, this apparatus becomes a part of the equipment of the department to which it most naturally belongs. The item of expense for equipment, therefore, does not enter into the general expenses of the Engineering Experiment Station. The value of this total equipment in the College of Engineering is now about $223,000.

The funds expended in carrying on the investigations, already completed and now in progress, have been during the last five years a little over $100,000, making an annual expenditure of about $30,000.

The existence of the Engineering Experiment Station at the University of Illinois makes it possible to utilize (1) the library facilities of the university, (2) the continual extension of the equipment of the various departments of the College of Engineering and (3) the helpful suggestions and cooperation of other scientific departments at the university. With these three aids the expenditure of our funds is bound to result in much larger returns than would be possible otherwise.

FUTURE WORK.—In determining the character of the work which the station shall undertake, the most careful consideration will be given first to the needs and the interests of the state of Illinois. Illinois is singularly favored in all the conditions requisite for rapid and permanent industrial development, and its interests cover


3 Tracks, 13' C. to C.
Subgrade
Cinder Fill
Water-proofing
Concrete 1:2½:5
1" Rods 8' C. to C.
Cinder Fill
C. L. of Bridge
Hor. and Vert. Rods in Parapet Wall: ½" @ 12" C. to C.
Concrete 1:2½:5
Half Section A-A. (At Crown)
Half Section C-C. (At Side Arch)
36' betw. Copings
C. L. of Pipe Railing
Cinder Fill
C. Line of Bridge
6" Tile
Half Section B-B. (At Pier)
Part Section D-D (Retaining Wall)

very wide fields of engineering activity. In view of its cheap and abundant fuel, its great agricultural wealth and its unexcelled facilities for the transportation of raw material and finished products, it is not surprising that Illinois is the second state in the Union in agriculture and third in manufactures. With these great resources devolves upon us great responsibility in developing and husbanding them. The testing of its materials of construction will always be a matter of importance for any state. The prevention of the waste of material growing more and more expensive, as wood, and the correct factors of strength of new materials, as concrete, are always subjects for the most careful investigation.

The work of the station will also extend into some fresh fields, seeking to discover new ways and means for economizing energy and materials, ways for the prevention of waste, for the perfection of labor-saving machinery, for safer methods of travel, and for surer sanitary methods of water supply and sewage disposal. Fuel supply is of such prime importance in our industrial development that no effort will be spared in the introduction and promulgation of improved methods and processes in the mining, preparation and consumption of coal. Along the line of power production there is opportunity for much investigation. New problems are confronting both the builders and users of steam and gas motors. There are questions relative to the economy of various types of power installations with given conditions of service. A careful investigation of the properties of heat media of all kinds, extending, if necessary, over a series of years, would furnish data of the greatest value to engineers, and would, in addition, be a noteworthy contribution to science.

Considerable work for the railroad interests has already been done by the railway engineering department of the university. This department owns jointly with the Illinois Central R. R. a dynamometer car equipped for steam-road experimental work. With this car there have been made numerous road tests for the establishment of tonnage ratings. The department also owns a 200-HP. electric car especially designed and thoroughly equipped for heavy electric-traction work. Railway work with both these cars will be prosecuted vigorously under the direction of the new school of railway engineering and administration recently organized. In the near future, an extensive series of tests on cast-iron columns, and on various forms of steel and iron structure members is contemplated.

The experiment station will investigate manufacturing processes. As an example of this line of work the high-speed steel tests are cited. Problems relating to design and construction will be studied, and all useful results will be published for the benefit of those engaged in design or construction. As a rule the experiment station will undertake only such investigations as will lead to results of fundamental importance, results that will be helpful to a large class of engineers or manufacturers. It will not, in general, undertake work of importance to individuals only, e. g., the testing of a device or invention for the sole benefit of the inventor.

The station is now planning to make more systematic study of the industrial and engineering interests of the state of Illinois, more particularly with the thought in mind that these industries should be advised as to the work already accomplished by the station, and also that more exact knowledge may be obtained concerning the needs of the various industrial interests throughout the state. Prof. K. G. Smith, in the capacity of Industrial Visitor, will visit the manufacturing centers of Illinois in order to become acquainted with the problems confronting these various interests, so that such fundamental problems as affect a large number of our industries can be taken up and such study of these problems made as facilities and funds permit.

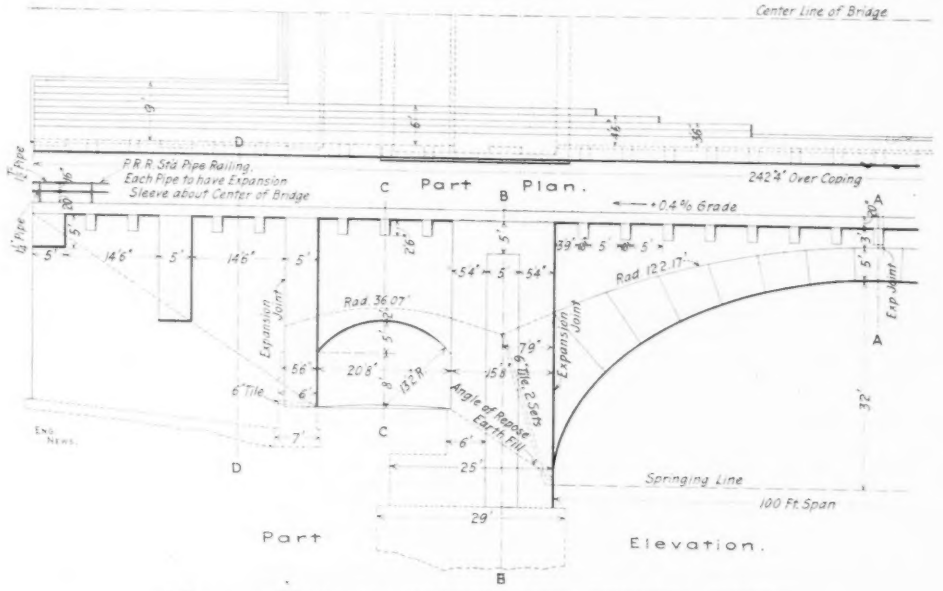


FIG. 3. DETAILS OF VOUSSOIR ARCH CONCRETE BRIDGE.

Coal Sampling and Analysis.*

By N. W. LORD,† M. Am. Inst. M. E.

Within the last few years the subject of coal analysis has become of very great importance to many lines of industry. The demand for the analysis of coal has come from a great variety of sources and largely from those having little acquaintance with chemical methods and the interpretation of chemical results. The chemists, on the other hand, have been compelled to take such methods as were found at hand, and the result of these conditions has been not altogether satisfactory in many ways.

If we consider somewhat in detail the various determinations made in the laboratory in connection with coal testing, it will be easy to show how much is commercial and how little is what might be called scientific. The so-called analysis of a coal is usually a practical test of purity of the material on a small scale, but it also involves determinations which are supposed in some way to indicate the nature of the coal itself.

To illustrate, suppose we consider an ordinary sample of bituminous coal. It may be assumed to consist, first, of an organic constituent composed of vegetable residues more or less altered but retaining traces of the original woody structure and composite character and containing as an integral part certain inorganic components. Like its source, woody fiber, it is hygroscopic in its nature, mechanically holding variable amounts of moisture, the equilibrium amount depending upon the moisture percentage of the air. In other words, like a piece of wood, it absorbs moisture in damp weather and gives it up in dry weather. The ultimate chemical composition of this material varies with the extent of the alteration, as shown in the peats, lignites, and bituminous and anthracite coals, and also, as has been shown, in all probability with the nature of the vegetation from which it has been derived. This extremely complex and indefinite material may be called "coal substance" for want of a better term. Intimately mixed with it are inorganic substances, probably mechanically introduced with the original vegetable debris or else precipitated by secondary reactions from circulating waters. They may be in the nature of clays or fine sand and also intimately mixed iron pyrites. I have examined samples of coal under the microscope, in which microscopic crystals of pyrites were scattered through the mass in sufficient amount to give a high percentage or sulphur in the total, yet in which a superficial examination of the coal itself practically showed no pyrites to the unaided eye. Other minerals may be present in the same way, even such unusual constituents as zinc blend and vanadium sulphide. The extremely complex nature of the organic constituents themselves may be inferred from the variable but sometimes very large amounts of sulphur they contain, well shown in the case of certain peats. Now in addition to this base, constituting the principal part of the sample submitted to the chemists for analysis, there is, secondly, more or less coarse admixture of slate, clays, other rock-like material occurring in connection with the deposits of coal and not properly separated in mining, bone coal, streaks of cannel and other associated material, coal-like in character, but differing notably even in the organic material they contain from the coal itself. Further consider the fact that many of these ingredients on standing or on exposure to air, alter by absorption of oxygen, evaporation, etc., and it would appear that the problem is still further complicated.

Now some of the things that the users of coal wish to know and for which they turn to the chemical analysis, in the hope of receiving information, are the following: The heating power of the coal; the amount of ash or inorganic matter left on burning the coal; the nature of the combustion of the coal, whether flaming, smoky, rapid or slow; the gas-producing quality of the coal both as to yield and as to the nature of the gas; the nature of the ash yielded by the coal; the coking quality of the coal and the purity of the coal produced; and the possibilities of improving its quality by coal washing.

What are the analytical methods at present used in the laboratory to meet this series of questions and to handle this very complex material? Most of the laboratory work is done upon a sample which represents or is intended to represent the average composition of the material and which in no way recognizes the separate constituents of the very complex mineral aggregate of which it purports to be an average. The methods therefore give results only approximately related to the coal substance and difficult of general application.

We have, as of generally recognized importance, the ultimate analysis as ordinarily made, giving the determination of the hydrogen, the carbon, the nitrogen and the sulphur and the percentage of ash left after burning. This analysis also includes an estimate of the oxygen by difference, which is of course only approximate, as has been frequently pointed out in discussion on the subject. This ultimate analysis is capable of a high degree of accuracy for certain elements, which I think could be safely stated within 0.05% on the hydrogen and 0.3% on

*Parts of an address before the Illinois Fuel Conference March 11, 1909, Urbana, Ill.

†Chief Chemist, Technologic Branch, U. S. Geological Survey, Professor of Mining and Metallurgy, Ohio School of Mines, Columbus, Ohio.

carbon, 0.03% on the nitrogen and 0.05% on the sulphur. I do not mean that closer results are not obtainable, but ordinary work in the laboratory by competent chemists would run within these limits. The value of the ultimate analysis in all technical applications of the coal consists of its giving a reasonably accurate basis for the calculation of products of combustion and of comparisons with the heating power of the coal otherwise determined. The weakest point in the ultimate analysis is the uncertainty of its connection with the actual composition of the organic material as distinct from the impurities. Carbon, hydrogen, and sulphur are present occasionally as carbonates, as combined water and as sulphates, respectively, in the slates and other mechanical mixtures and the ultimate analysis does not distinguish between such occurrences and that in the coal substance. Ingenious efforts to eliminate these uncertainties as affecting the heating power by examination of various samples of the same coal differing widely in percentage of mechanical impurities have been made by several chemists.

In addition to the ultimate analysis, we have the more commonly made "proximate analysis," consisting of the determination of the moisture, ash, fixed carbon and volatile combustible matter in the coal. Much has been written in regard to these determinations. On the same sample of coal closely agreeing results can be obtained on the ash and fairly close on the moisture. The variation in the volatile combustible is much larger and can only be kept within reasonable limits by very careful adherence to a definite method of procedure. The term "moisture" simply means the loss in weight under fixed conditions of treatment. It is intended to bring the material to a condition which can be duplicated closely and represents a fixed basis for comparison, and it does, but it stands in no wise for all the water in the coal. The volatile combustible is by no means properly named. Only a variable fraction is combustible and a considerable fraction, consisting of water vapor, carbon dioxide, nitrogen and other diluents is inert or non-combustible. It is well to recollect that the proximate analysis of coal was devised many years ago and primarily as a means of testing the amount of coke left by coal. The volatile combustible has since been the subject of much discussion and many attempts have been made to correlate it with heating value, geological changes and the various questions arising in coal utilization. Some undoubted connections have been shown, but I feel that possibly too little recognition has been given to the empirical and more or less uncertain nature of the determination.

Of growing importance, particularly in connection with coal washing, and as a tool for the study of coal samples is the application of the separation by gravity or the so-called "float and sink" tests. In these the coal, crushed to a moderate degree of fineness, is separated on solutions of high specific gravity, chloride of calcium for specific gravities up to 1.35 and chloride or sulphate of zinc for higher gravities. Chloride of zinc solutions can be made of specific gravity as high as two. The method is excellently adapted to tracing out the variations in composition as the intermixed mineral substances are eliminated. It will enable the experimenter to distinguish with considerable accuracy between the inherent intimately mixed ash and sulphur compounds and the coarser and mechanical contaminations.

In recent years the leading factor in the commercial valuation of coals has become the calorific value or "heating power" and to-day the most important demand on the laboratory is the determination of this. The widely extending use of the bomb calorimeter is leading to new problems for the investigation of the chemists. Here again the heating value of the sample is modified more than by mere dilution by the nature of the mineral aggregate. The heating value is not entirely proportional in a given kind of coal to the residue left after deducting the ash and the moisture, but there are factors depending on the influence of the inorganic material. Work of this kind is of great importance in order that the effect of ash, moisture and pyrites on the commercial value of coals may be more accurately shown.

Calorimetry is, unfortunately, work demanding considerable training and experimental skill and the recently adopted policy of the Bureau of Standards of furnishing materials of known heating value so that the constants and correction of the calorimeter can be determined is greatly to be commended. The possibility of error in calorimetric determinations due to alteration of samples should be borne in mind. A very finely pulverized coal sample will oxidize in many cases rapidly and comparative results by different chemists on such a sample are liable to be unsatisfactory unless all are made at approximately the same time on samples that have been sealed in air-tight receptacles.

The determination of the water equivalent of the calorimeter experimentally gives rise to many difficulties and hence except for those having had a great deal of experience in fundamental measurements it is far better to use the calorimeter as a comparative instrument and depend for its constants upon burning substances of known calorific value such as are furnished by the Bureau of Standards. Commercial chemicals are quite variable and different samples of napthalene, benzoic acid, etc., from different dealers, will differ notably in their heating value. Recently the writer has obtained very successful results by the method of mixtures, adding hot water to the calorimeter from the Dewar flask or "thermos" bottle in which it is possible to read with great accuracy the temperature of the added water and to add the water to the calorimeter with a very small correction for radiation loss during the addition. The method has proved successful in the hands of students who have made a number of water equivalent determinations agreeing within a very small limit of error with the calibration of the calorimeter obtained in other ways. Of course, this method has the advantage of being absolute and not relative.

The foregoing outline has dealt with the laboratory side of the question. All the analytical work, calorimetric work, and everything else in connection with the testing depends for its economic value on the fundamentally representative nature of the sample of coal tested in the laboratory. Here is the weakest point in the commercial application of the results. Coal sampling is a matter now prominent before the technical world. Now that the extending recognition of the value of laboratory work is leading to the purchase of coal on chemical specifications the whole question is under review. The figures most affected by sampling obviously are on moisture, ash, sulphur and calorific value.

The sampling methods of the Geological Survey have been criticized and I feel called upon to correct certain misapprehensions in regard to that work and the accuracy with which the sampling was done. The assumption has been made, in such criticism, that portions of a carload sent to the gas-producer, briquetting and washing plants were identical in composition with a general carload sample, and that variations shown in different portions were due to variations in sampling at the various plants. In fact, however, the different portions of a carload, unloaded at different plants, were not intended to be sampled from the car but from the portions unloaded. It was recognized that the carload was not uniform as far as ash, sulphur, etc., was concerned and that the carload analysis could not be taken as applying to the several portions without a thorough mixing of the whole carload.

Two things are important to consider in coal sampling. First, in crushing coal a large proportion of fine material is produced so that the average size of a particle produced is but little more than half the maximum size of particles. Results of the distribution of the maximum-size pieces then greatly exaggerate the difficulties of securing a good sample. I recently took four samples of screened coal and had them put through a jaw crusher and screened. In No. 1 sample, 8.8% was retained on a ½-in. screen and 56.4 passed a ¼-in. screen. At this stage of the crushing, two 5-lb. samples of the screenings were taken and each was separately pulverized, mixed and analyzed. One portion gave 13.86% ash and the other 13.56%. A similar trial was made of No. 2. Sample; 16.3% remained over a ½-in. screen and 46.65% went through the ¼-in. The first portion gave 14.59% ash and the second portion gave 14.49%. Sample No. 3 gave 7.3% over a ½-in. screen and 48.3% through the ¼-in., while the respective ash contents were 15.11% and 15.10%.

Of course, these results are too few in number to amount to anything, but they show that the finer material is in sufficient proportion to diminish the irregularity introduced by the bad distribution of the coarser lumps in the sample.

The second point in coal sampling which has to be considered is that in the larger sizes there is a natural mixture in the material of the slate and coal, so that 4-in. lump coal does not represent a mixture of 4-in. lumps of coal and 4-in. lumps of slate. In other words, the inspection element must enter coal sampling, and no man would draw a moderate sized sample of a coal in which he has a large percentage of lumps of slate as large as the lumps of coal, while the occasional presence of even a large lump of slate would have but little influence on the ash percentage of the resulting sample.

The moderate variations in the ash percentage of the different lumps would have far less influence in disturbing sampling than the presence of equivalent sized lumps of slate. Obviously, therefore, careful inspection must precede the sampling in the case of lump coal and the presence of large pieces of slate and pyrites in lumps in the coal taken into consideration in determining the size of sample necesary in order to properly sample the coal. I have always directed samplers to inspect the coal carefully and break up into small pieces any lumps of slate, bone coal or pyrites found, or anything else that did not look like coal before taking or dividing the sample.

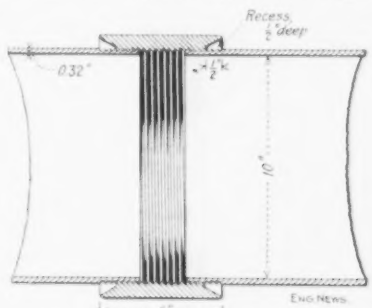
Of course, it is well known that no system of sampling which is purely mechanical is satisfactory for materials in which coarse distribution of the components exists, unless the whole of the material is crushed. This is the principle involved in the continuous sampling of lead and copper, gold and silver ores, where the system of sampling involves the crushing of many tons of material. Such a system of decimal sampling is, of course, out of the question with lump coals where the crushed material would be rendered of small commercial value. The system of sampling adopted in this case must be based on an estimate of the maximum size of slate and pyrites, constituting an important portion of the impurities.

The difficulty of eliminating the personal element in doing such sampling is a problem to be contended with. It must be solved before the laboratory analysis reaches its full application.

A 10-in. Steel Water-Supply Main for the Water-Works of Montcalm, P. Q.

By RAOUL RINFRET.*

Montcalm is a suburb of the city of Quebec. It is situated on a high bank of the River St. Lawrence. Water is brought to the town by gravity, across a valley nearly 300 ft. deep. Besides this height, which only brings the water to the town, there is a head of 200 ft. for fire protection which makes an elevation over the lowest point of the valley of 500 ft., roughly. Spigot and faucet cast-iron pipes to stand this pressure could easily be designed, but the joints, which would have had to be made of lead, could not be considered as safe. Flanged and bolted cast-iron pipes were then $58.00 a ton and 10-in. steel pipes could be bought for $1.39 per ft. At these figures steel pipes were over 40% cheaper, and they were



Joint for Steel Water-Supply Main, Montcalm, P. Q.

chosen, although cast-iron pipes would resist rust longer, they being thicker. The pipe used is made of mild steel, 0.32-in. thick, asphalted inside and outside, lapwelded. The pipe is of American make, and was tested to a hydraulic pressure of 800 lbs. per sq. in.

The accompanying sketch shows how the joints are made. On account of the great pressure some of the joints leaked, although red lead was used in painting the screwed ends of the pipe before connecting them. To stop the leaks cold lead was calked in the triangular recess shown in the section. The lead is easily kept in place, in spite of the pressure, by the threads of the screwed part of the pipe. The strip of lead should be big enough to fill the recess well after it has been calked.

The steel pipes, once screwed together, are rigid. In order to follow the surface of the ground and avoid deep trenches, or dumps over the pipe to protect from the frost, vertical bends had to be made. Extra heavy cast-iron flanged fittings were used to change the direction of the pipe. In order to get the angle of the fitting, so as to get it cast, a careful level of the ground was made, a section drawn with equal vertical and horizontal scales, and the angle then measured on the drawing. On the screwed end of the pipe a companion flange was screwed and it was connected to the special fitting with bolts, brass gaskets being used.

In the deep valley referred to above there is the River St. Charles, 200 ft. wide. Beneath the river a double line of pipes was laid, with a gate valve at each end of each line of pipe, so that in case of a break one line can be closed and repaired, while the other line is used for the service.

The steel pipe is used where the pressure is 135 lbs. per sq. in. or over. Elsewhere spigot and faucet cast-iron pipe is used, with lead joints.

The steel main was laid in the summer of 1908. The writer was engineer for the town of Montcalm, which owns the new water-works described.

*260 Rue St. Jacques, Montreal, P. Q.

A Cost Record System Used for Work Done by Day Labor.

At Grand Rapids, Mich., some important work is under construction to prevent the periodical flooding of the city by the Grand River, which flows through the city. The work includes the widening and deepening of the river channel, and the construction of reinforced-concrete retaining walls (or rock embankments in some places) along the sides of the channel. As auxiliary to this is the construction of a system of intercepting sewers (with pumping plants for use during flood stages) on each side of the river.

The work along the river was done by day labor under the direction of the city engineer, the funds being furnished from time to time by appropriations from the common council. For this work a special cost-account system was devised by the engineer-in-charge, Mr. C. S. Keating (now of Adrian, Mich.), and was described by him in a paper which was presented at the recent annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago. From this paper we take the following particulars of the system:

The writer arranged and installed a cost account system. This included a general distribution sheet for the bookkeeper's use, cards for each division of the work (showing the amount of work done each day and the labor cost of same), and cards for recording minute observations for use in arranging men and teams to the best advantage. The writer kept the time personally, so as to keep a more efficient account of the work and check up the distribution from the cards each night with the bookkeeper and one by the writer. The bookkeeper's sheet was used for all accounts, and the writer's sheet for payrolls only. At the end of each week, the payroll was totaled and checked with the distribution for that time for that day. He found that by keeping the time he became familiar with the face and dress of each man, and when watching the work, could readily tell the position of each man and the work he was doing. This was a great help where a large number of men were employed.

The cards used for this work were the ordinary blank filing cards, 8 × 5 ins., and were ruled and marked by the writer as fast as they were needed.

The general distribution sheets were 38 × 24 ins., ready ruled horizontally, and ruled vertically in the office to correspond to the various headings, as shown in Fig. 1. A tracing was made of the heading of the sheet and blue-prints made, which were carried by the city engineer and the writer to use for reference in writing orders for material, etc. One of these sheets was used by the bookkeeper and one by the writer. The bookkeeper's sheet was used for all accounts, and the writer's sheet for payrolls only. At the end of each week, the payroll was totaled and checked with the distribution for that time for that day. He found that by keeping the time he became familiar with the face and dress of each man, and when watching the work, could readily tell the position of each man and the work he was doing. This was a great help where a large number of men were employed.

The cards used for this work were the ordinary blank filing cards, 8 × 5 ins., and were ruled and marked by the writer as fast as they were needed.

The general distribution sheets were 38 × 24 ins., ready ruled horizontally, and ruled vertically in the office to correspond to the various headings, as shown in Fig. 1. A tracing was made of the heading of the sheet and blue-prints made, which were carried by the city engineer and the writer to use for reference in writing orders for material, etc. One of these sheets was used by the bookkeeper and one by the writer. The bookkeeper's sheet was used for all accounts, and the writer's sheet for payrolls only. At the end of each week, the payroll was totaled and checked with the distribution for that

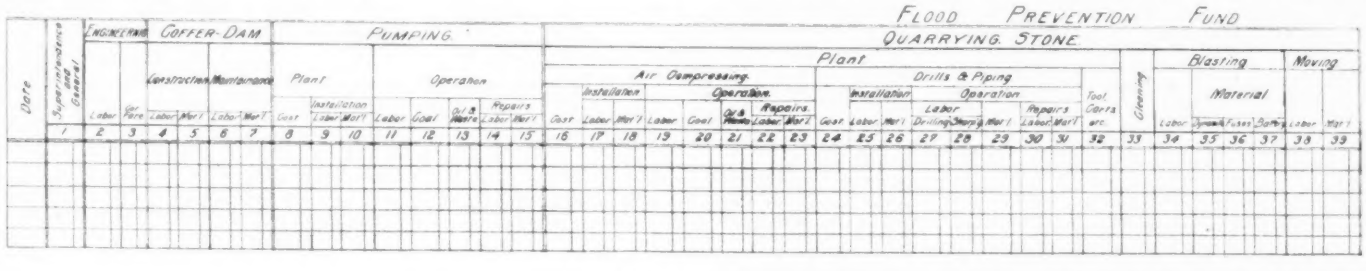


FIG. 1. HEADINGS FOR THE GENERAL DISTRIBUTION SHEET OF THE

general sheet, the first is the daily report of coffer-dam construction (Fig. 2). This example gives the card as it appeared for Feb. 22, 1905. No new sections were built or put in place, 5 sections were filled, making a total length of 80 ft. finished. Men filling: 4 at $1.75, 3 at $2; 4 teams at $5 hauling clay, and 3 men at $1.75 digging clay and loading. In connection with the heading "Men Placing" it may be explained that it took a number of men to bring the sections to place (which was done by the use of ropes), on account of the current in the river and the swirl around the end of the section already in place. The time for these men, which would be but a few minutes for each section, was kept by the foreman making note of the work from which each man was taken. In making up the distribution each night, the time for placing was deducted from the work as indicated by the foreman's report. The bags used on this work were old grain sacks and were obtained from the various milling companies in the city at a cost averaging about $6.50 per 100.

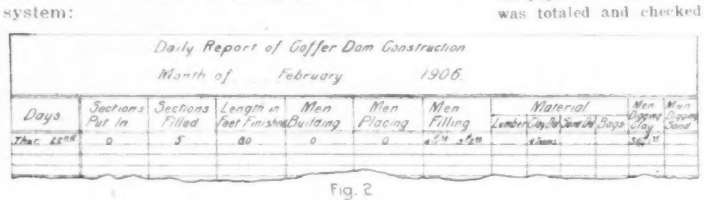


Fig. 2

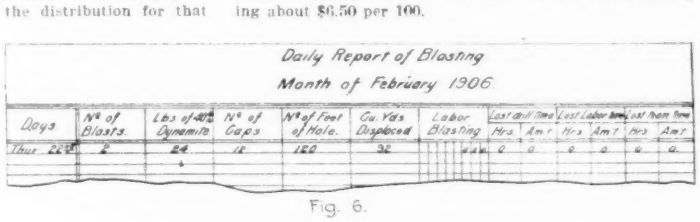


Fig. 6.

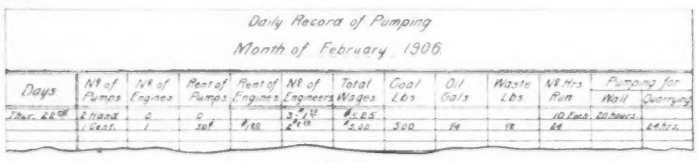


Fig. 3.

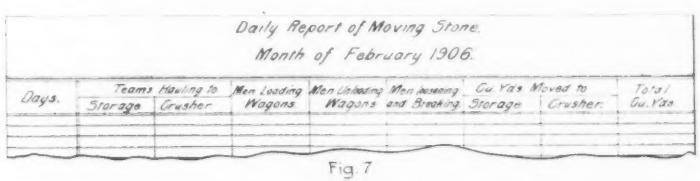


Fig. 7

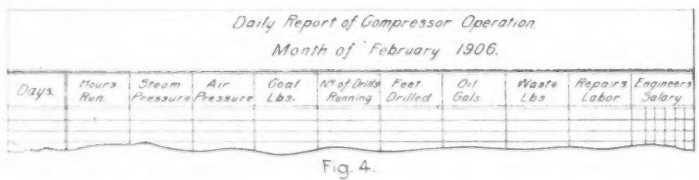


Fig. 4.

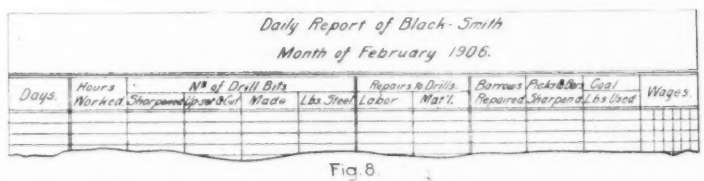


Fig. 8.

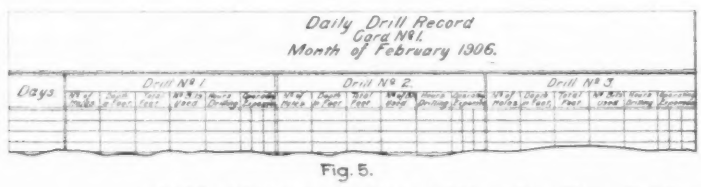


Fig. 5.

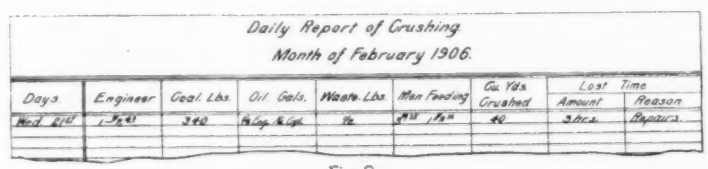


Fig. 9.

COST-ACCOUNT BLANKS USED FOR THE FLOOD PROTECTION WORKS AT GRAND RAPIDS, MICH.

The administrative department of this work consisted of a superintendent and the writer. The former had charge of the men and of the direction and arrangement of the work. The writer had charge of the engineering and business portions. He had also the purchasing of all machinery, supplies, materials, fuel, etc.; looked after the various plants, keeping them in repair and good running order, and attended to the renting of all grounds, machinery, etc., and the direction of the teams.

Referring to the accompanying sketch of this general sheet (Fig. 1): under the heading of superintendence and general, was charged the superintendent's salary, carfare, cost of office, the lighting, watchman's time and part of the bookkeeper's time. To engineering was charged the writer's time and carfare, and the time and carfare of the field party giving lines, grades and taking cross-sections. The remaining headings are self-explanatory.

Taking the cards in sequence, to correspond to the week, tabulated on the sheet, a list made out to correspond, and sent to the bookkeeper with the time-book and tabulated on his sheet. Order blanks were used when buying materials, etc., and the distribution numbers put on each item. These were in duplicate, one going to the seller and the other to the office. In this manner the bookkeeper had no trouble in keeping his accounts correctly distributed.

The first example given on the "Pumping Record" (Fig. 3) is actual, the other is merely for illustration. The amounts of coal, oil and waste used were obtained by dividing the quantity received at that pump by the number of days run to exhaust the supply. The hand pumps were used for the wall only and the steam pumps for the quarry only.

The daily report of compressor operation (Fig. 4) is self-explanatory. The sections of "drills running" and

"feet drilled" were used on this card for comparison. In the daily drill record card (Fig. 5) the operation of 5 drills necessitated the use of two cards to keep the record. The number of bits used for each drill, each day, was generally 8, there being 4 bits in a set and usually two sets were dulled in a day's running. The last column is to receive the wages paid the drill runner and helper.

The daily report of blasting was kept as shown in Fig. 6. The number of cubic feet displaced was measured on the surface, and multiplied by the depth of the exposed face. The last three headings for lost time are for time lost in leaving the quarry while blasting, but as most of the blasting was done at quitting time, noon and night, there was very little of this to account for.

The report of moving stone needs no explanation further than the headings on the card, Fig. 7.

The blacksmith's report is shown in Fig. 8. As to the "drill bits sharpened," when the bits became too dull to do efficient work, they were heated, driven into a die and tempered. As to "upset and cut," after a bit had been sharpened a few times it became so small across the base as to bind in the hole, then it had to be upset, the leaves cut in and sharpened. The blacksmith made all the new bits needed.

On the crusher report, Fig. 9, the number of cubic yards crushed was obtained by tallying the number of yards in the bins, the amount hauled to storage, sold and that used in the wall.

(Figs. 11 and 12) were made occasionally to get the most out of the drills. Also to get the best distribution of men for loading and unloading stone, so as to cut the time lost while the teams were standing to as small an amount as possible, while at the same time working the men to advantage. For example: When the number of men loading or unloading brought the price per cubic yard above the price of a preceding observation and the corresponding decrease in lost team time was not sufficient to balance it, it was evident that there were too many men loading or unloading and the force was decreased accordingly. The observations of drilling were taken to get the best results from the drills and keep the men from loafing when making new set-ups or changing bits.

Under the head of loading on the stone card (Fig. 12), the "size" gives the dimensions of the wagon box; the "time" is the number of minutes and seconds taken to load, and the "total time" is the time multiplied by the number of men. "Hauling" is the time taken in going from the point of loading to the point of unloading and returning. The sub-headings under "unloading" are the same as for "loading." The number of yards in the load is taken from the size of the wagon box, and the cost is figured by dividing the total time multiplied by the rate of wages, by the number of yards in the load. The total cost will be the sum of the costs per yard multiplied by the number of yards.

The "material received" card (Fig. 13) was used merely as an additional check on the orders and to prevent any firm from charging up rejected material, and to keep a record of orders filled in part.

The order blank (Fig. 14) was used in general by the engineer's office when purchasing materials or supplies.

The stone slips (Fig. 15) were printed for this work and served the double purpose of a sales slip and tally on the time the teams were taking in making the deliveries. At the top is the kind of stone, the size of the wagon, the weights, and the scales used. Along the right-hand end are the hours from 5 a. m. to 7 p. m., and the minutes (by tens) for each hour. As the team was loaded, unloaded and returned the time was marked with the letter of indication, shown at the bottom, in the minute square opposite the proper hour. At the bottom, the month, day and year are indicated by punching. The body of the slip is used for the purchaser's name, the place of delivery and the driver of the team. The words "ground" and "loaded" were used to designate respectively whether the stone sold was loaded from stone piled on the storage ground or loaded from the quarry.

From these cards and slips, taken together, the unit cost of any piece of work or any part of the work can be obtained. This is done by assembling the various items included in the work, from the card for that work and the items on the cards for any other division of work that may be chargeable to that work, in whole or in part.

For example: The cost of the crushed stone used in constructing the wall will be derived from the cost of crushing and quarrying. The quarrying in turn will include pumping, compressor operation, interest, depreciation and maintenance, drilling and moving stone, the blacksmith's work chargeable to drilling and tool repairs, the blasting, and the cost of coffer-dam. The record of the number of men or teams or both, at work on any piece of work for each day, gives more concise data regarding the working conditions of the work, than would

GRAND RAPIDS, MICH. 1905-6.

CRUSHING. | WALL.

Plant: Crusher: Cost	Crusher: Installation: Labor	Crusher: Installation: Mat'l	Engine: Cost	Engine: Installation: Labor	Engine: Installation: Mat'l	Bins: Labor	Bins: Mat'l	Operation: Engine: Labor	Engine: Coal	Engine: Oil & Waste	Engine: Repairs: Labor	Engine: Repairs: Mat'l	Crushing: Labor	Storage: Repairs: Labor	Storage: Repairs: Mat'l	Storage: Labor	Storage: Mat'l	Excavation: Earth: Labor	Earth: % Rate	Rock: Drilling: % Compr'r	Drilling: Labor & % Drills	Drilling: % Tools	Blasting: Labor	Blasting: Materials: Powder & Fuses	Blasting: Materials: Cutting	Hauling	Concrete: Mixing: Mixer: Cost	Mixer: Interest	Mixer: Depreciation	Mixer: Labor	Concrete in Place: Material: Labor	Material: Cement	Material: Sand	Material: Gravel	Material: Misc.	Rock Filling	Forms: Mat'l	Forms: Labor	Stone Yard: Handling	Hauling	Totals
40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	

COST-ACCOUNT SYSTEM FOR FLOOD PROTECTION WORK AT GRAND RAPIDS, MICH.

Daily Report of Work on Wall.
Month of February 1906.

Days	Bbls of Cement	Cu Yds of Sand	Cu Yds of Stone	Men Mixing	Men Placing	Men Building Forms	Material Forms	Material Placing	No Cu Yds in Place
Wed. 21st	26.5	9	21.5	6 9 14	4 5th 4 5th	2 5th 1 5th	440 f.b.m.	108 f.b.m.	21.5

Fig. 10.

Minute Observations of Drilling.
Drill No. ____ Kind ____ Size ____
Runner ____ $ per hr. Helper ____ $ per hr.

Date	First Bit: Change	First Bit: Down	First Bit: Pump	Second Bit: Change	Second Bit: Down	Second Bit: Pump	Third Bit: Change	Third Bit: Down	Third Bit: Pump	Fourth Bit: Change	Fourth Bit: Down	Fourth Bit: Pump	Hours not Drilling	Remarks.

Fig. 11.

Minute Observations of Moving Stone.
Weather ____ Condition of Road ____
Length of Haul ____ to ____ Men ____ $ per hr. Team ____ $ per hr.

Date	Loading: Size	Loading: No of Men	Loading: Time	Loading: Total Time	No Trip	Unloading: No of Men	Unloading: Time	Unloading: Total Time	Hours to Load	Lost Team Time	No of Yds in Load	Cost per Yd in cts.: Loading	Hauling	Unloading	Return	Lost Time	Total Cost

Fig. 12.

Material Received and Accepted.
Week Ending Wednesday ____ 1906.

Order No.	Date	Received from	Quantity	Items	Price	Amount	Distribution No.

Fig. 13.

COST-ACCOUNT BLANKS USED FOR THE FLOOD PROTECTION AT GRAND RAPIDS, MICH.

City Engineer's Office.
No. ____ Grand Rapids, Mich. ____ 190 ____
Bought of ____
Price Amount
For Work of ____ City Engineer.

Fig. 14.

BOARD OF PUBLIC WORKS.
ENGINEERING DEPARTMENT.
No. 7081

Limestone Building Broken Screened Boulders Broken
Load—1 Cu Yd 1/2 1 1 1/4 1 1/2 2 2 1/2
Total Wt. Tare Net Wt. Where Weighed
A. M. 5 6 7 8 9 10 11
P. M. 12 1 2 3 4 5 6 7
Sold to ____
Ground. Loaded. Delivered to ____
RECEIPT to be signed by Purchaser and returned by Driver to Quarry.
Driver.
PURCHASER Sign Here
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
1906 1907 1908 1909 1910
LOADED L
DELIVERED D
RETURNED R

Fig. 15.

On the report of wall work, Fig. 10, the figures given are for illustration and are not actual. The amount of cement used was obtained by tallying the bags as they were used and checked by counting the empty bags at night. The lumber was measured in the forms each night by the writer. The concrete was measured in the forms and the work of each day lined out on the outside of the forms.

The "minute observations of drilling and moving stone" be the case if merely the total amount of time for the day was recorded.

By filing these cards, with a table for each showing the amount of work accomplished each day, together with the average cost per day, covering any convenient length of time or obtained after the completion of the work, excellent data would be kept for use in making estimates on work of the same character, making due allowance for the varying conditions.

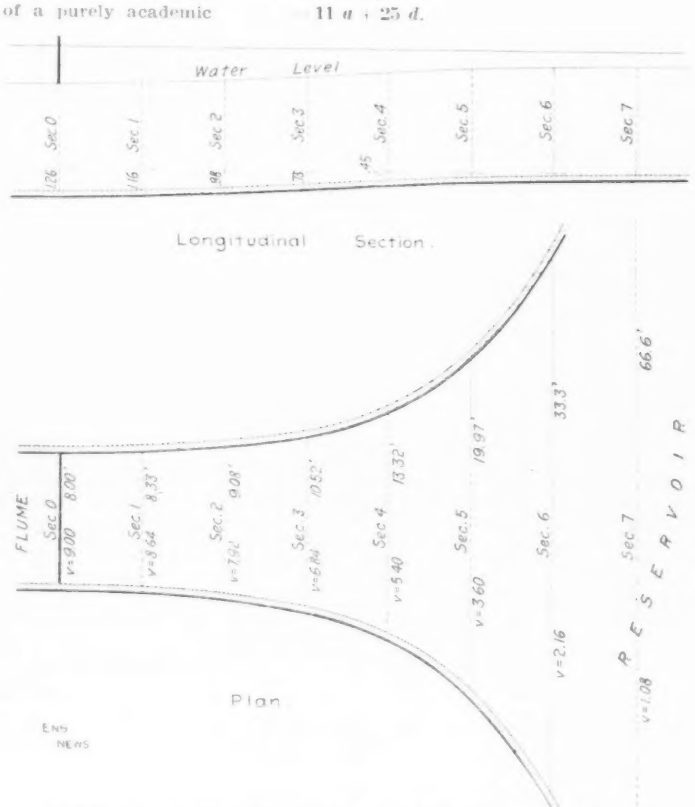
The Design of Intakes for Hydro-Electric Plants.*

By JEAN. BART. BALCOMB,† Assoc. Am. Inst. E. E.

Perhaps no feature of hydro-electric installations has received so little consideration, or been more often constructed by "rule of thumb," than the intake at the head of the canal system. With a view to suggesting a rational, and at the same time practical, method of designing such works, the writer offers the following method employed in his own practice. Much of the mathematical matter, of a purely academic nature, is inserted for the benefit of the younger engineers who are just approaching commercial hydraulic problems.

Taking an actual case, we find that the velocity used was 9 ft. per sec., the width of flume 8 ft. and the depth of water 6 ft. 6 ins. Practical considerations determined the length of intake as being 45 ft. to 50 ft., measuring from the headgate (placed at the head of the flume) well into the reservoir. Sections were taken every 5 ft., beginning with Sec. 0 at the headgate and numbering toward the reservoir, Sec. 10 being the full width of the latter.

In order to reach the highest efficiency, it was determined to avoid all angles and irregularities, either horizontal or vertical, with a view to obtaining the smoothest possible flow while accelerating the water to the desired velocity. This required the slope to be 0 at the reservoir, to increase gradually to some unknown maximum and then decrease gradually until it joined the flume with the same slope as the latter: also, the sides of the channel to curve continuously, instead of being a uniform slant as frequently made.



DETAILS OF AN INTAKE FOR A HYDRO-ELECTRIC PLANT.

The above considerations necessitated a design such that the variation in the acceleration of the water should be uniform; in other words, that the various accelerations produced between the different cross-sections should form an arithmetical progression. Neglecting friction, which is allowed for in later calculations, these variations range from 0 through a certain maximum back again to 0; the actual velocity of the water constantly increasing, but at a varying rate. Since the acceleration both starts with and returns to 0, there will be eleven values. The first six will form an ascending progression, the last six (counting the middle one twice) being simply a repetition of these in the inverse order. Using the algebraic formulas

$$l = a + d\,(n-1)$$

$$s = n\,\frac{a+l}{2}$$

where in each series:

a = first term.
l = last term.
n = number of terms.
s = sum of terms.
d = common difference between terms.

In this case:

s = sum of each half series.
s' = total sum of two series = 9.
a = 0.
n = 6.

then

$$s' = 2\,s - l,$$
$$= 11\,a + 25\,d.$$

We solve for d, obtaining a value of 0.36—the amount by which the acceleration should be increased or decreased from station to station.

With the rate of acceleration determined, it is a simple matter to write the complete series as given in the second column of Table II. The velocities are obtained by adding each acceleration (Table I.) to the preceding velocity, beginning at velocity 0, at section 9.

The following computations may be made with the slide rule much more rapidly than otherwise. With care, the resultant error is less than one-half of 1%. Since the calculations are carried to three places of decimals and the final results tabulated to only two, the error is not only practically but absolutely negligible. In his own practice the writer deems it best always to check results so as to avoid cumulative errors. Such checks are suggested in the present article.

Since the quantity of water is to be constant and it was desired to have the depth remain the same, the width of channel will vary inversely as the velocity, their product being a constant—Vw at Sec. 0. In the present instance this constant is 9×8 or 72. Expressed as an equation, this relation becomes

$$Vw = 72$$

or

$$w = \frac{72}{V}$$

where

V = velocity at the given cross-section.
w = width of channel at the same section.

Substituting the different values of V and solving for w gives the widths corresponding to these velocities. In computing the friction head, mean proportional velocities and widths will be used, so these, found by multiplying together two successive values and extracting the square root, are given also in Table I.

As a check on the above, it is well to multiply together mean proportional values set opposite each other and see if their product is 72. Since the equation

$$Vw = 72$$

is true for any section, it must likewise hold for mean proportional values.

The hydraulic radius, being the ratio of the area to the wetted perimeter, is found at once by multiplying the depth by the width and dividing the product by the sum of the width and twice the depth. It is convenient to express this relation as an equation in which

$$r = \frac{D\,w}{2\,D + w}$$

with

r = mean proportional hydraulic radius.
D = depth of water.
w = mean proportional width.

As the depth of water is to be 6.5, the formula reduces to

$$r = \frac{6.5\,w}{13 + w}.$$

The resulting values are given in Table I.

The next step is to determine the velocity head, by means of the gravity acceleration formula

$$V^2 = 2\,g\,h$$

or

$$h = \frac{V^2}{2\,g}$$

where

V = velocity at the given section.
g = 32.2.
h = head required to produce V.

By substituting the different values of velocity from Table I., the resulting values of h give the required fall from Sec. 9 to the section under consideration.

Another method, giving equally satisfactory results, is to differentiate

$$V^2 = 2\,g\,h$$

obtaining

$$2\,V\,dV = 2\,g\,dh$$

or

$$dh = \frac{V\,dV}{g}.$$

dh gives the fall from section to section directly; V being their mean velocity and dV the acceleration from Table I. Applying this to Sec. 9-8,

$$dh = \frac{0.18 \times 0.36}{32.2} = .002.$$

These determinations give the head or fall required to produce the desired velocities, neglecting the friction on sides and bottom.

To determine this latter factor, it is necessary to apply Kutter's coefficient in the formula

$$V = c\,\sqrt{rs}.$$

The solution is made for s instead of V. For this purpose,

V = mean proportional velocity.
n = .012 (for planed lumber).
r = mean proportional hydraulic radius.

Solving the equation and multiplying the slope

*See Design of Intakes in Eng. News, Dec. 24, 1908, p. 703—in "Some Problems in Designing * * * Power Plant," by F. C. Finkle.

†With Lake Construction Co., 1104 The Temple, Chicago.

TABLE I.

Sections	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
Acceleration	0.36	0.72	1.08	1.44	1.80	1.44	1.08	0.72	0.36
Mean velocity	8.82	8.28	7.38	6.12	4.50	2.88	1.62	0.72	0.18
Mean propor. Velocity	8.82	8.27	7.36	6.08	4.42	2.79	1.53	0.62	....
Mean propor. Width	8.17	8.71	9.77	11.84	16.33	25.82	47.2	115.7	....
Mean propor. hydraulic radius	2.51	2.61	2.79	3.10	3.62	4.33	5.10	5.84	....
Sq. rt. of mean pro. hydraulic radius	1.58	1.62	1.67	1.76	1.90	2.08	2.26	2.42	....
Velocity head	.099	.185	.247	.274	.252	.129	.054	.016	.002
Friction head	.007	.006	.004	.003	.002	...	...	...	....
Fall calculated	.106	.191	.251	.277	.254	.129	.054	.016	.002
Fall used	.11	.19	.25	.28	.25	.13	.05	.02	.00

TABLE II.

Section.	h	Velocity.	Width.
0	1.258	9.00	8.00
1	1.159	8.64	8.33
2	.974	7.92	9.08
3	.727	6.84	10.52
4	.453	5.40	13.32
5	.201	3.60	19.97
6	.072	2.16	33.3
7	.018	1.08	66.6
8	.002	.36	200.
9	.000	.00	Infinity

s thus found by 5 (the distance between sections), gives the friction head required to maintain velocity.

There are a number of tables and diagrams from which the value of c in the formula may be found so as to avoid the tedious solution of the formula. These values, together with those of the mean proportional radius and its square root, are given in Table I.

Since friction heads, in designs like this, are very small, they are sometimes neglected entirely. A better plan, in case they are not computed, is to give the intake the slope of the flume, in addition to that required for velocity head. Since the intake, at all points, has a greater cross-section than the flume, it is evident that the error will be on the safe side. The slope of the flume in the present instance being .0015 would give a fall of .068 in the intake, instead of .022, the correct amount; a difference of a little over half an inch too much.

The amount of head to be allowed for the grizzly is at best a matter of approximation. If placed well up toward the reservoir, where the velocity is low, its effect will be almost negligible and will be offset by the velocity of approach due to stream flow. This is the desirable location, but incurs the greater expense. If computed, it may be assumed that the velocity is inversely proportional to the restricted waterway, the additional head required being the amount which will produce this extra velocity. The restricted waterway may be figured by using the actual space occupied by the bars of the grizzly, if the velocity is low, or twice this amount where the water is flowing swiftly, the difference being due to what might properly be termed end contractions at the bars.

While the writer is a firm believer in carrying out computations rigidly to a predetermined degree of accuracy, so as to preclude possible cumulative errors; yet in tabulating the final values for use in the field, it is well to bear in mind that there are other factors to be considered, of equal or greater weight than mathematical refinement. The following are suggestive of such practical considerations.

If the plant uses the major portion of the stream's flow there will always be a perceptible velocity of approach as a resultant of the velocity in the stream. On the other hand, if a large part of the water flows over the wasteway or dam, there may be slack water at the intake, or even eddies which actually cause a flow in the opposite direction. This feature depends on the configuration of the reservoir and should be considered in its design. Also, the depth of water flowing over the waste weir increases the head from the reservoir by that amount. It is seldom possible to predict this with accuracy owing to the fluctuations in stream discharge. Frequently it more than offsets any possible loss due to the presence of a grizzly, unless the latter becomes clogged with weeds and leaves.

These considerations serve to emphasize the fact that in engineering design and construction it is necessary to season the results which are obtained with slide rule, logarithms and formula by a wise admixture of "common sense" in their practical application.

THE PUNCTUALITY OF HIGH-SPEED TRAINS is shown by figures published by the Pennsylvania R. R. Co. for its 18-hr. train between New York and Chicago. In 1907, out of 365 trips each way, the eastbound train was on time 278 days, the westbound on 280 days; the total number of minutes late was 4,046 and 4,131, giving an average throughout the year of 11.1 mins. and 11.3 mins., respectively, or an average per late train of 46.5 and 48.5 mins. Great improvement is shown by the corresponding figures for 1908, when out of 366 days 314 eastbound and 314 westbound trains were on time, and the total number of minutes late was 1,838 and 2,423; this shows an average delay throughout the year of 5.0 and 6.6 mins., and an average delay per late train of 35.4 mins. and 47.5 mins. respectively. This train is scheduled to cover the distance of 912 miles at an average speed of 50.7 mi. per hr. Incidentally, the figures for some 370,000 passenger train trips on the Pennsylvania system during 1908 showed that 88% made schedule time or better. The percentages for the above high-speed train are almost up to the same percentage, showing equal reliability of service.

Concrete-Lined Mine Shafts at Filbert, Pa.

In our issue of Sept. 24, 1908, p. 330, we published an article by Mr. L. L. Brown describing the lining of a mine shaft with concrete. The shaft there described, in the low country bordering on the Susquehanna near Wilkesbarre, Pa., was driven through the water-bearing earth to solid rock some 80 ft. below the surface. At this level the concrete was stopped and the shaft continued through the rock, without concrete lining. The shaft, then, was in reality the approach to the actual mine shaft and the main difficulty in its construction was the resisting of the heavy pressure of the ground water in the saturated earth. In a number of cases of late this use of concrete in mine shafts has been carried further and the shaft itself lined with concrete. Such a piece of construction is now being built by the Frick Coal Co., of Pittsburg, Pa., in its new mines at the town of Filbert, near Brownsville, Pa.

These shafts are sunk through about 18 ft. of earth to rock and thence about 630 ft. to a 9-ft. coal vein. When the construction was under advisement bids were asked on both timber and concrete linings for the shafts. The concrete price was considerably the higher of the two, but the size of the coal vein promised profitable working for so long a time in the future, that the concrete, with its consequent minor maintenance and renewal charges, was accepted.

There are two shafts at present under construction; the hoist shaft and the ventilating shaft. In design and construction they are both about the same, although the former is 13 × 28 ft. in elliptical plan and the latter 14 × 34 ft. elliptical. They are each divided into four vertical compartments, by horizontal and vertical timbers. On the left is the ventilating chamber, the middle left is the down cage, the middle right is the up cage and the right is for the emergency stairway. The cage trucks are supported on timber buntons, which form the dividing struts for the above-noted compartments and which are spaced vertically apart 5 ft. c. to c. They are of 8 × 10-in. timber, placed in the concrete as it progressed, an operation that governed to a large measure the section and design of the forms.

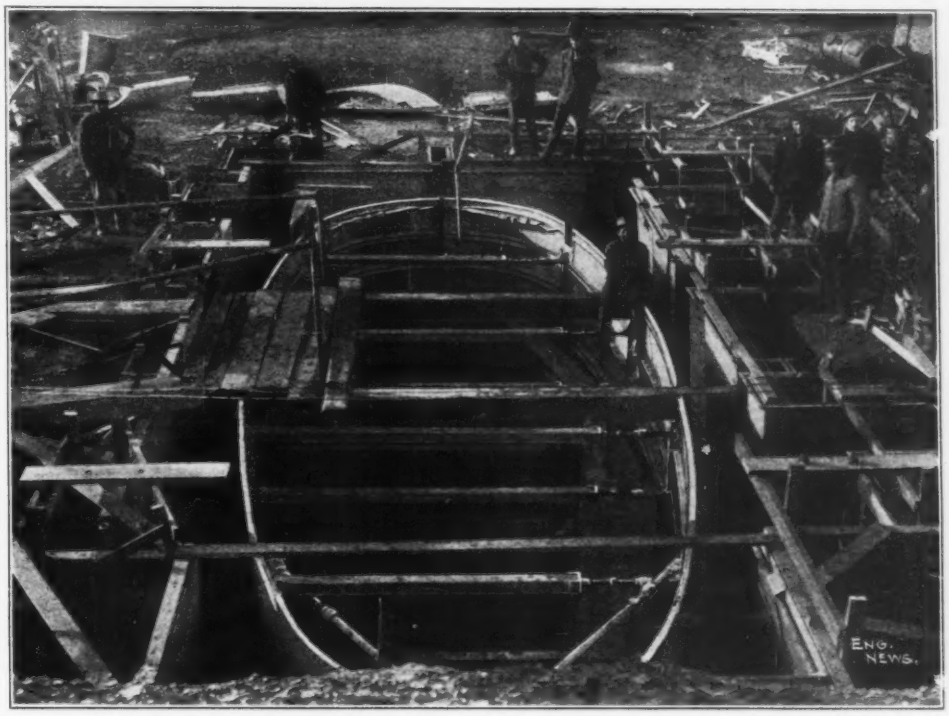


FIG. 1. VIEW DURING CONSTRUCTION OF CONCRETE SHAFT LINING. FRICK COAL CO., FILBERT, PA.

Through the upper 18 ft. of earth the shaft structure is of heavy concrete construction with the irregularly shaped plan on the surface shown in Fig. 2. This plan extends down to rock with

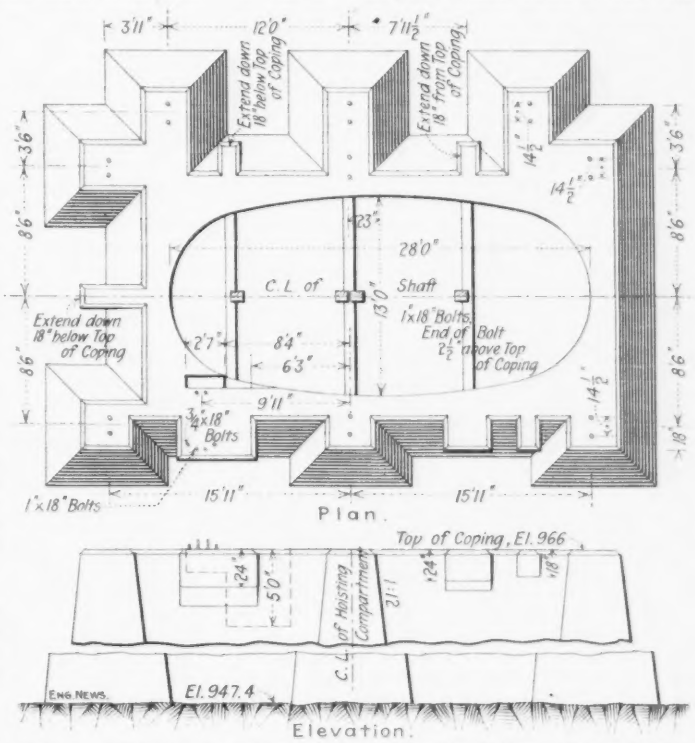


FIG. 2. DETAILS OF PORTION OF HOISTING SHAFT ABOVE ROCK.

the additional buttresses shown on the figure. Below this elevation the excavation is made in the solid rock on a line 12 ins. outside the designed elliptical shape of the shaft and a solid wall of concrete 12 ins. thick placed to bring the hole to the proper shape and size. Special steel forms, made by the Blaw Collapsible Steel

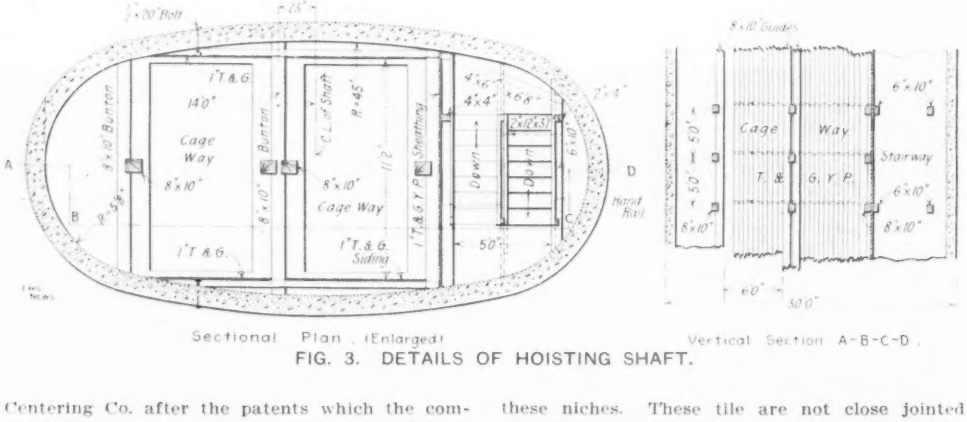


FIG. 3. DETAILS OF HOISTING SHAFT.

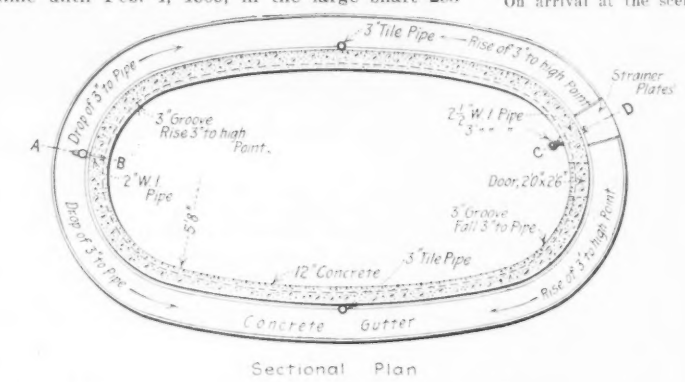
Centering Co. after the patents which the company uses in sewer centers, are being successfully used in laying the concrete.

The form for the 14 × 34-ft. shaft will be described; the other is exactly the same except in circumferential dimensions. This 14 × 34-ft. shaft has a periphery about 80 ft. 6 ins. long and for this periphery the form is divided in 10 units, each about 8 ft. wide and 5 ft. deep. These when bolted together complete the form for a 5-ft. depth, and as there were 10 of them made there are enough forms to cover 50 ft. in depth of the shaft at one time. Each 5 × 8-ft. section is built of No. 10 steel plate, reinforced at the top and bottom with 4-in. channels, to the outstanding legs of which the adjoining sections are bolted. Additional horizontal channels and angles provide extra reinforcement. On the sides of each unit there are riveted 4-in. vertically placed channels, to which, at each end, are placed small angles to be used in bolting together adjacent units. Thus each section 5 ft. deep is composed of 10 units, varying from length 8 ft. 9 ins., weight 500 lbs., to length 7 ft. 2 ins., weight 380 lbs., all bolted together into an elliptical cylinder 5 ft. deep. To provide for placing the buntons, openings were cut in the proper places on the top of each section into which the timber was slipped just previous to connecting. Each section is interbraced with adjustable steel rods and timber struts, placed under the buntons so as not to interfere with the excavating and concreting.

In construction the excavation was first made by ordinary drill and blast methods to a depth of 50 ft. through the hard blue shale rock, keeping 12 ins. outside the shaft line by means of a template above carrying plumb bobs. Although not saturated as earth might be the rock contained many water-bearing fissures which made excavating very uncomfortable work for the men but did not otherwise hinder the progress of the sinking. This water was allowed to run until the concrete was placed, when it was cared for as afterward described. When the 60 ft. was excavated 10 units of form were bolted together and lowered to within 10 ft. of the bottom of the hole, thus forming a complete circumferential form 5 ft. deep. This section was concreted, the buntons being placed at the same time, and the next 5-ft. section placed on top of it in a similar manner. When all of the 10 sections were so filled and 50 vertical feet concreted the excavation was resumed, another 50 ft. excavated and the concreting operation repeated, removing the first form placed for the first section to be placed. It was found that concreting and excavating could not be carried on at the same time in the same shaft, so that the two shafts were utilized for the successive operations; while concreting was going on in the hoist shaft, the excavating gang was working on the ventilating shaft.

The water in the rock is cared for by the "water ring and strainer" shown in Fig. 4. At stated intervals in the depth of the shaft a deeper cut is made in the side wall of rock all around the shaft. The bottom of this depression is then concreted in gutter form. Now at various points around the shaft 3-in. tile are set vertically, during the concreting, leading down into these niches. These tile are not close jointed and are backed up with loose rock to allow seepage into them. In addition at each niche there is a groove and projection made in the inside wall of the concrete, leading on a descending grade around to a pipe which feeds into the niche. Thus all the water both in the rock and on the inside face of the concrete is collected in the niche from which it is led by the concrete gutter through a strainer to an outlet pipe and is thence pumped out of the shaft.

Work was started Aug. 6, 1908, and from that time until Feb. 4, 1909, in the large shaft 293



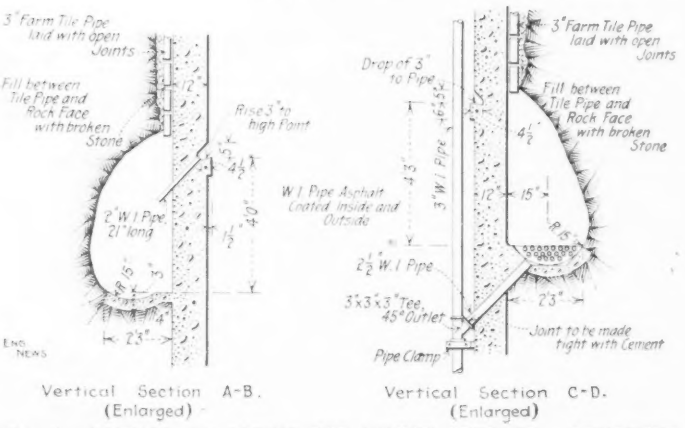

3" Farm Tile Pipe laid with open Joints
Fill between Tile Pipe and Rock Face with broken Stone
Rise 3" to high Point
2" W.I Pipe 21" long
W.I Pipe Asphalt Coated inside and Outside
3" W.I Pipe
2½" W.I Pipe
3"x3"x3" Tee, 45° Outlet
Pipe Clamp
Joint to be made tight with Cement
Vertical Section A-B. (Enlarged)
Vertical Section C-D. (Enlarged)

FIG. 4. METHOD OF CARING FOR WATER SEEPAGE. CONCRETE-LINED MINE SHAFT, FRICK COAL CO., FILBERT, PA.

ft. had been sunk and 269 ft. lined with concrete, while in the small shaft 235 ft. had been sunk, of which 201 ft. was lined. Now that the work is progressing in good running order about 13 ft. per week of total work, including excavation and lining, is being accomplished.

The shafts are being built for the H. C. Frick Coal Co. by W. F. Patterson & Son., of Avalon, Pa. Mr. J. P. K. Miller is Chief Engineer for the coal company and Mr. A. F. Allard is the Constructing Engineer.

THE EAST CHICAGO CANAL is being built by the East Chicago Co., of Indiana Harbor, Ind., to give water communication between Lake Michigan and the great industrial district now being developed around the city of Indiana Harbor. It will accommodate large lake steamers and thus provide for the direct delivery of ore and freight. The canal will be 3.5 miles long, with a bottom width of 200 ft., and a depth of 20 ft. of water in the present portion (1.5 miles) and 15 ft. in the part yet to be built. There will be ten railway bridges (some of which were described in our issue of March 18) and four highway bridges; three of the latter (temporary structures) have been built. Mr. C. W. Hotchkiss (General Manager of the Chicago, Indiana & Southern Ry.), of Chicago, is consulting engineer; Mr. Fred. Norlin (Chicago Opera House Block, Chicago), is the engineer in charge. The contract for construction is held by the Great Lakes Dredge & Dock Co., of Chicago.

HARBOR ROCK REMOVAL under difficulties is described in a paper by Mr. C. W. Maclean, before the Institution of Civil Engineers, entitled "Removal of Submarine Rock at the Entrance to Port Phillip, Victoria." This harbor, situated at the head of a long indentation of the south coast of Victoria, Australia, is the entrance to the ports of Melbourne and Geelong. Owing to a peculiarly dangerous current or tide swirl, due to certain conditions of wind and tide, it became necessary from 1902-04 to cut a channel 37 ft. deep at low water and 2,000 ft. wide, through the neck of the harbor, requiring a maximum removal of about 5 ft. depth of rock. On account of these same cross currents it was impossible to carry on the blasting except at the 10 to 20 minute slack tide. The working time for a single tide, for mooring the boats, laying the charges on rock and paying out the wires, was only about 60 minutes.

The rock was a calcareous sandstone, very easily shattered by explosions placed on its surface, so that the placing of the explosive was quite simple, once the boat was in place. The method of blasting was as follows:

The flotilla employed consisted of a dismantled twin-screw gun-boat, a surf-boat to contain charges and divers, gear and a whale-boat for running out and lifting the moorings of the surf-boat.

On arrival at the scene of operations, as soon as the tide slackened sufficiently, the surf-boat containing the explosives was cast off and moored in position, the marine surveyor directing the work from the whale-boat. The bags of explosives were then suspended over the side about 8 ft. apart, and when they hung plumb they were lowered on top of the rock. The moorings were then lifted and the boats removed to a distance of about 300 yds., when the firing cables were coupled to a dynamo-electric machine, and the whole of the charges were exploded simultaneously. At the commencement of the operations divers were employed to place the charges on the rock to the best advantage, but, owing to the almost constant swell this method proved too slow. By using the shore marks established for survey purposes, and working systematically along one line before shifting to another, the rock was broken down in continuous sections, and a quarry face of 4 ft. to 5 ft. was obtained, which ensured the shattered rock being thrown down towards deep water, thus preventing any temporary shoaling of debris.

The high explosives used so pulverized the rock that only in a few instances was it found necessary to further reduce the detached masses by smaller charges. Consequently, disintegration and removal of the debris by the strong tidal currents were rapidly accomplished. The results obtained were due chiefly to the softness of the rock to be removed, and the use of heavy charges of explosives especially suitable for submarine work. The men employed, although unfamiliar with the work during its initial stages, became, with experience, so expert that, in the 1904 season, two shots were fired on a tide. The double shots, which were made up independently and fired alternately, were placed at least 70 ft. apart to avoid premature or imperfect explosion of the second set of charges by sympathetic detonation.

A special equipment was attached to the steamer at the end of the season, by means of which the depth of cut could be determined. This consisted mainly of two vertical posts of old rails, counterweighted with bags of sand.

In all, about 4,950 cu. yds. of rock was removed at a cost of about $35,000. This gives a high unit cost, but not too high considering the nature of the work and that the steamer was in use only 30% of the time it was in commission.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

GEORGE H. FROST, President
CHARLES WHITING BAKER, Vice-President
HARWOOD FROST, Secretary
FRANCIS W. FROST, Treasurer

ALFRED E. KORNFELD, Manager
EDWIN HUNT FROST, Ass't Manager

CHARLES WHITING BAKER, M. N. BAKER, E. E. R. TRATMAN, F. E. SCHMITT, } Editors

SUBSCRIPTIONS

United States and Possessions, Mexico and Cuba, One Year, $5.00.
Canada, $7.00 a Year.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0.), 45 Francs or 37 Marks.
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $7.00. 29 Shillings, 35 Francs or 29 Marks. Remit directly to our office.
Pay no money to canvassers for subscriptions.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter.
Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Subscriptions cannot be dated to commence with past issues.
All subscriptions commence with current issue and back numbers can be supplied only by special order.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year. 52-9 means the 52d week or December 26, 1909.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages.

Copy for regular, or "Contract," Advertisements should be received at least ten days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

In our issue of March 11 we noted the program of a fuel conference, at Urbana, Ill., under the auspices of the University of Illinois, the Illinois Geological Survey and of the U. S. Geological Survey. A paper read at this conference by Mr. D. T. Randall, of the U. S. Geological Survey, has been reprinted in part elsewhere in this issue, and this paper will be found of real practical help to those younger engineers throughout the country, who may be designing small steam-power plants. We believe from experience and observation that the local coal situation is not studied, during the designing of innumerable small boiler plants, with all possible profit. "Catalog engineering" is apt to prevail too much. Empirical relations between grate area and heating surface are selected; a coal of recognized merit is assumed used; and the draft layout is adapted to the recommendations of the boiler maker. In most technical schools the need of studying the local coal market is discussed, but three or four years later the young designer does not readily see an approach to the balancing of those coals and furnaces available. The paper by Mr. Randall gives this start and shows the comparative ease with which the furnace design may often be adapted, at little or no extra cost, to burning poorer but more available fuels.

The administration of the water-supply of Greater New York is at best no simple matter. Attempts to reduce its complexity were evidently made by the Charter Revision Commission (see Eng. News, March 25, 1909), but the Commission seems hardly to have been so successful in securing simplicity and unified, in place of divided, responsibility here as in other parts of the charter.

An analysis indicates that under the new charter responsibility for the water-supply of New York City would be divided between the board of estimate and apportionment, the city council, the commissioner of water-supply and the city and state health departments. No little responsibility would also fall upon the mayor, inasmuch as he would appoint the commissioner of water-supply and the commissioner of health. The one decided gain in simplicity would be the abolition of the aqueduct commission. The new charter makes no reference whatever to the board of water-supply, which, like the aqueduct commission, is almost outside the general scheme of the city government of New York.

Under the proposed new charter the commissioner of water-supply, although responsible for the administration of the water-works, would yet be under the jurisdiction of others in the following particulars: The board of estimate and apportionment would select all sources of supply and would have the full power of causing meters of a pattern and price approved by it to be fixed on all consumers; the rates or charges for water, although fixed primarily by the commissioner of water-supply, would be subject to the approval of the board of estimate and apportionment, but rules and regulations regarding the use of water would be subject to provisions of the proposed administrative code (supplementary to the charter) and to the city council. It would be the duty of the commissioner of water-supply to maintain the quality and preserve the purity of the supply, but it would also be the duty of the health department "to take all steps necessary for the sanitary supervision of the water-supply of the city" and its sources. A further qualification of the charter is to the effect that all sources of water-supply would be subject to such sanitary regulations as the State Department of Health may require.

While there may be good reasons, historic, traditional, or inherent to the general scheme of city government, for this division of responsibility, yet we think it evident to any one familiar with water-works administration that the commissioner of water-supply might advantageously be given more freedom from other departments than is proposed by the new charter. In particular, we see no reason why meters and metering consumers should be put so completely within the control of the board of estimate and apportionment. Of all the hundreds of manufactured articles used by the city of New York, why should meters alone have been singled out for specific mention in the charter, and placed in the control of the board of estimate and apportionment? No one expects, we dare say, that the mayor, the comptroller, the president of the board of aldermen and the five borough presidents who compose the board of estimate, will be elevated to office by the 700,000 voters of New York City because of their peculiar fitness to pass upon water meters. Is it any more essential to good government in New York that the board of estimate and apportionment should pass upon the type and price of water meters, than upon styles and cost of pumping engines, fire hydrants, fire engines and fire hose, and hundreds of other devices and supplies?

Why should the commissioner of water-supply have to go to the board of estimate and apportionment for approval of the water rates he may formulate, whereas in the matter of regulations of the use of water he would be tied hard and fast by the administrative code, or be subject to the city council?

And why, above all, should there be continued the present pernicious division of responsibility as to the purity of the water-supply, so that the commissioner may take his choice between laying the blame for improper safeguarding of the water-supply upon the city commissioner of health or upon the state commissioner of health, and each of these may choose between blaming the other and laying the blame upon the commissioner of water-supply? Of course no such division of responsibility as we have pictured is really intended by the framers of the charter; but we cannot believe that they thoroughly appreciate the necessity of having the responsibility for the purity of the water-supply of 4,000,000 people placed squarely and definitely and singly upon some one person.

The proposed abolition of the aqueduct commission seems to be highly commendable. It was created 20 years ago or more for the purpose of introducing an additional supply of water from the Croton drainage area, and before its work was completed another board, likewise independent of the city government in most particulars, was created to bring in water from another source. There seems to be no reason whatever why the aqueduct commission should not be abolished as proposed, all the works which it has completed turned over to the proposed commissioner of water-supply, and further construction in the drainage area, if any, be put in the hands of the new board of water-supply.

Aside from water-works superintendents, few people have any idea of the large quantities of water that are wasted in every city of the country through defective water-closets. A special feature of this waste has recently been brought to public attention by a communication to the New York "Sun" from Mr. Ernest Flagg, an eminent New York architect. Mr. Flagg asserts that the "hush pipe" costs the taxpayers of New York City at least $3,000,000 a year. He explains this as follows:

> A "hush pipe" is a small pipe about 6 ins. long which muffles the sound of leaking ball cocks in water-closet cisterns; without the "hush pipe" the leaking water would disturb people, and without it an incredible number of people would be disturbed for the leaking water-closet is the rule, not the exception. My observations have convinced me that most water-closet ball cocks leak after they have been in use a year or more.
>
> The water-closet cistern leak is a most insidious affair; it is cunningly concealed. The leaking water enters the cistern noiselessly through the "hush pipe" and runs down without appearing in the bowl of the closet. To the casual observer no leak is apparent, even though considerable water may be passing through. One might use a leaky water-closet for years without suspecting it.

Mr. Flagg then goes on to say that he has a block of model tenements containing some 500 water-closets. The water supplied to these buildings is metered. After the buildings had been in use for some time he found himself "engaged in a race between the water bills and the rents." To make a long story short, meter readings were finally taken between 1 and 4 a. m., and the leakage was found to be through the water-closets. The "hush pipes" were taken off and the leaky ball cocks repaired. After this the water consumption and water bills "fell off two-thirds."

Mr. Flagg calculates the average leak from each water-closet in these tenements at 210 gals. per day. Estimating that there are 500,000 water-closets in New York, the leakage from this source would be 105,000,000 gals. per day. That leaks of this kind are general Mr. Flagg is convinced by observations and inquiries made since the incident recounted. He recommends regular inspection of all plumbing fixtures: the prohibition of the "hush pipe;" and the arrangement of all water-closet systems so that the water will fall from the tank directly into the bowl of the closet.

We wish to call attention to the fact that it seems to have been only the water meter that brought even so well-trained and public-spirited a man as Mr. Flagg to a realizing sense of the waste that goes on through fixtures that are not subject to proper inspection and repair. It should also be noted that leaks are by no means confined to the particular class of fixtures in question.

The argument for water meters is gaining public recognition day by day. Only recently an eminent water-works engineer was heard to remark that he considered the campaign for meters virtually ended; that is to say, the work of education has now been largely done, and what remains is chiefly to buy the meters and put them in place. Of course there are exceptions to this, but in general we think the engineer is right. The meter not only greatly curtails waste, but it is the only fair method of apportioning the cost of water service between the various classes of consumers, even if the careless could be eliminated. Carelessness can never be wholly eliminated, but the most effective means toward that end, at least in the United States, is to make the consumer pay for all the water he allows to run to waste.

All who have even a faint conception of the nature and difficulty of accurate census taking will be pleased to know that civil service principles will govern most of the appointments for the census of 1910. This, coupled with the fact that

the Census Bureau is now a permanent organization, gives promise that the 13th census will be better than any heretofore taken. Besides saving a considerable amount of inefficient work, it is probable that by taking appointments out of politics, as the Census authorities so earnestly desire, no small sum of money will be saved also.

Clear Specifying, and the Nova Scotian Steel-Coal Lawsuit.

One of the first principles of contract-writing is to say definitely what you mean to furnish or mean to get. A curious instance of neglect of this principle a few years ago gave rise to a great lawsuit in Canada, which has just reached final decision by the English Privy Council.* The case was a great one not because of its technical importance but because of its complex business and other relationships, and because few suits for breach of contract come before the courts that involve such large amounts as here contended for. What interests us, however, is the simpler technical aspect of the matter.

The case was between the Dominion Iron & Steel Co. and the Dominion Coal Co., and rested on a rather remarkable contract for the purchase of coal, made between the companies in 1903 but terminated in 1906 by a dispute, the coal furnished being unsuitable for the Steel Company's use. The latter sued for damages and an order to enforce specific performance. The Supreme Court of Nova Scotia awarded damages, and the Privy Council has now affirmed the judgment.

The contract operated to establish a sort of commercial interest between the two companies, which had originally been allied businesses. The Steel Company, a large coal user, wanted to procure a reliable nearby supply of good coal, while the Coal Company, being a large producer, naturally desired to obtain its neighbor's entire custom, especially because large industrial consumers were not plentiful in that vicinity. A contract intended for mutual advantage was therefore drawn. Under its terms the Steel Company would continue to be a steady customer of the Coal Company, but a preferred customer, at a very low price per ton, in consideration of binding itself not to purchase elsewhere.

Three years later, trouble developed over the contract. It appears that either the contract was imperfect, or else one of the parties was seeking to interpret it unlawfully. The Coal Company was then furnishing coal unsuitable for the Steel Company's use. This was at a time of large demand, it has been alleged, and coal could be sold elsewhere at much better prices than the Steel contract specified. At any rate the coal offered was so high in dirt and sulphur as to be useless for the Steel Company's furnaces, who promptly rejected it. Yet the fact is that the contract did not specify definitely what kind of coal was to be furnished; at least its specification did not clearly exclude such coal as was offered. All the subsequent discussion and litigation revolved about the question of what was *implied* by the contract outside of its strict expressed meaning.

The express stipulation as to quality was as follows:

> (3) All coal furnished shall be freshly mined, and of the grade known as "Run of mine," reasonably free from stone and shale, and shall be supplied from such seams then being worked by the Coal Company as the Steel Company may designate. The Coal Company may, after the expiry of four years from the date of this agreement, supply slack coal of the same specification as to quality as above if suitable for use in steel making and for blast furnace coke, and may also supply slack coal for other purposes for which it can be used without disadvantage by the Steel Company. In construing the above clause the use of slack coal shall not be deemed to be a disadvantage merely because the use thereof necessitates changes in the grate bars of the Steel Company. "Suitable" shall be construed to mean that the slack coal so supplied when properly washed by the Steel Company shall not contain a percentum of impurities, to wit, ash and sulphur, appreciably greater than the percentum of impurities in the same coal of "Run of mine" grade when crushed and washed in the same manner. All coal supplied hereunder that requires to be washed shall be washed by the Steel Company, and should the Steel Company establish and operate a coal-washing plant between the point of origin of such and the Steel Company's blast furnaces, the Coal Company shall, at the actual cost thereof, allow such coal to be washed in transit.

*Quoted in full in the Montreal "Gazette" of Feb. 19, 1909.

It will be noted that nothing is said as to limiting sulphur in the run-of-mine coal, while as to the slack, it need only be as low in sulphur and ash as the run-of-mine, *provided this amount will make the slack suitable for steel and coke making.* This further requirement, being restricted to the slack, is clearly an additional specification beyond that provided for run-of-mine. In other words, the run-of-mine coal is held to be sufficiently protected by three requirements: (1) that it come from a designated seam, (2) that it be freshly mined, and (3) that it be reasonably free from stone and shale.

Obviously, such requirements are highly defective. Yet it is difficult to read any other meaning out of the clause quoted. One might expect, therefore, that trouble would soon arise over matters of quality of coal.

That the contract ran for two years without trouble is accounted for as follows: Under the clause quoted, the Steel Company designated a particular working, the Phelan seam. In 1903 this seam was producing perfectly satisfactory coal. Later, however, much of the coal produced from the seam was very high in sulphur. Under the earlier conditions the wording of clause (3) sufficed to give the Steel Company suitable coal; in 1906, however, it no longer sufficed, unless it were possible to find in the contract an implied limitation of sulphur.

Undoubtedly both parties knew, when the contract was made, that the coal in question was to be used for steel-making, and that high-sulphur coal would not do. But, of course, written words are supposed to express and supersede the unspoken views of the contracting parties, and only the written word governs the performance. If the contract later proves disadvantageous to one party, he is nevertheless bound by it, even though both parties may have been aware, or might be presumed to have been aware, of further conditions that possibly might bear on a question of performance.

Thus, if the Coal Company knew that the contract would be useless to the other party unless the coal furnished were low in sulphur, yet it could fairly conclude that the Steel Company had so drawn its specification as to provide for coal of desired quality, and that, in any case, the specification was the criterion. We must remember that the contract nowhere stated in so many words that the coal furnished was to be suitable for steel-making uses, or that its sulphur content should not exceed a specified amount. The Coal Company seems entitled to any advantage which the written contract afforded it, unless indeed the contract were so one-sided as to have no standing before a court.

That there could be any doubt as to whether suitability was *implied*, however, arose from a further peculiarity of the contract. The first two clauses contained a detailed statement of the kinds of furnaces, etc., for which the coal was to be supplied. There were two limitations on the amount that the Coal Company bound itself to supply: one, that it should not be required to furnish coal for factories of finished material (i. e., more finished than rails and splice bars); and two, that it should not be required to furnish more coal than needed for four blast-furnaces, etc., and their associated power and handling services. Apparently, the Coal Company wished not only to prevent reselling of coal furnished at the low price of the contract, but also to reserve for itself as direct customers all factories of finished material which the Steel Company might later establish; besides, of course, fixing a limit to the amount which it would be bound to furnish at the contract price.

The legal discussion centered on whether these quantity clauses did not also operate (or were intended) to describe the quality of coal to be furnished, by describing the uses to which the coal was to be put. In case they did have this effect, obviously it would still be an open question who would determine whether a given lot of coal was "suitable" for the uses described; if it was to be left wholly to the decision of the Steel Company, the contract would be one-sided, while if it was to be agreed upon as occasion demanded, one would expect the contract to make mention of such future agreements, and this it did not do.

The courts, however, took the view that the quantity clauses do in fact operate to specify quality. Says the Privy Council:

> It is not, in their Lordships' view, a case in which it is necessary to import by implication words into a contract in order to effectuate the common intention of the parties to it. What is necessary is to determine what they meant by the language they employed. The numerous authorities cited in argument dealing with the principles upon which terms are to be so introduced into a contract need not, therefore, be discussed. * * *
>
> It is clear upon the evidence that coal may satisfy all the requirements of paragraph three, and yet be so overcharged with sulphur as to be quite unfit to be used for metallurgical purposes. And the contention of the Coal Company is that, though over 90% of the coal supplied to the Steel Company was, as they knew well, required for those purposes, yet they are under no obligation to deliver coal reasonably suitable for them, provided only it satisfies the requirements of paragraph three. Both parties, the Coal Company alleges, knew the nature of the coal taken from the seam. Up to the date of the agreement it was, with the exception of what came from the east side of pit No. 4, all suitable for the smelting operations carried on by the Steel Company. Guided by this knowledge, the Steel Company (they urge) concluded that the provisions of paragraph three afforded them adequate protection, and that they were, therefore, willing to take their chance as to the purity and fitness of the coal to be won from the seam or seams they might designate. The function of paragraph one, the Coal Company allege, was merely to furnish a measure of supply.
>
> No doubt there is much to be urged in favor of this view; but, on closer examination of the several provisions of the contract, it appears to their Lordships not to be the true view of the mutual rights and obligations of the parties.
>
> * * * In the absence of such a limitation [of number of furnaces, mills, etc., other than the subsequent separate limitation to four furnaces] the enumeration could not afford any measure of quantity, yet it must be taken to have been introduced for some purpose, and the only purpose it can apparently subserve is to specify precisely and in detail the various uses to which the coal to be supplied was to be put. There would be no object, however, in doing this if the Coal Company was not at all concerned with the suitability of their coal for these uses.

More than this, however, the high court sees in the wording of clause (3) itself an implied requirement of suitability.

> The standard set up is, no doubt, a standard for slack, but it is strange that the freedom of the slack from sulphur be measured by the purity in the same respect of the coal, if the amount of sulphur, at least in an organic form, contained in the coal was a matter with which the Coal Company had no concern. * * * The whole clause seems, therefore, to suggest that the suitability of the run-of-mine coal for the uses indicated was within the contemplation of the parties when they entered into the contract.

The Coal Company is therefore held to an interpretation of the contract beyond its specific terms. They must supply coal suitable for the furnace and coke-oven uses described in the contract, in spite of the fact that the contract does not state that the coal must be suitable. They are not condemned to specific performance, but to payment of damages for the loss of the contract.

This may be excellent law. The highest court of Nova Scotia and the British Privy Council have said so, at least. Moreover, the moral obligation is perhaps in line with the judgment rendered. But we must observe that a very lengthy and expensive lawsuit was necessary to reach this decision.

For other contracts we think the law laid down here might prove an unsafe reliance. We are sure that contracting parties will always find it cheaper and less troublesome to specify exactly what they intend to obtain, rather than let the law puzzle out a meaning which the written contract may presumptively imply. The principle is well-known, but its observance seems to be neglected at times.

REINFORCED CONCRETE IN THE MESSINA EARTHQUAKE.—From investigations made on the ground by an engineer of the Hennebique reinforced-concrete firm, it is shown that there was perfect coherence in all the parts of the reinforced-concrete buildings which went through the earthquake at Messina, particularly in those which were in the most shaken districts. One typical example is cited of a house now standing in the middle of a quarter where all the other buildings are reduced to fragments, a house sheltering a family who are the sole survivors within a large adjacent area. The 1,000,000-gal. reinforced-concrete reservoir supplying the city with water has suffered no damage and has not been out of service at all.—M. Flament-Hennebique before the Société des Ingenieurs Civils de France.

LETTERS TO THE EDITOR.

Against Sweeping Pullman and Other Railway Cars While Occupied.

Sir: The custom, prevalent on many railroads, of having the porter dust and sweep out occupied cars when nearing large cities appears to the writer as most unsanitary and not in keeping with the very desirable attempt toward public education in the prevention of bacterial diseases. Within the past six weeks the writer has retreated to the "smoker" before the cloud of dust raised by the porters sweeping, on at least four of the leading railways of the U. S.; three times from a first-class coach and once from a Pullman. In each case the car was full of passengers inhaling the disease-laden dust raised by the porter's broom.

This is only an illustration of what happens daily in hundreds of cars. At best, railway passenger coaches used by the public present plenty of difficulties in sanitation. It seems that such dust as will remain on the floor, where most infection lies, should not be disturbed by the porter's broom.

Of course the railroad's attempt to keep its cars clean is very commendable, and no criticism of that is meant, but only a desire to bring forth further discussion as to the method of doing this. Newspapers, fruit parings, and other trash should be removed and woodwork should be wiped off with a cloth before receiving passengers.

The writer feels that another step will be taken toward the prevention of tuberculosis and other diseases when railway coaches are thoroughly cleaned with compressed air at the end of the run, and no sweeping or dusting is done while the cars are occupied by passengers.

Yours truly,
Jos. E. Craig, City Engineer.

Manistee, Mich., March 29, 1909.

Water Consumption and Waste in New York City and Elsewhere.

Sir: In an editorial which appeared in the New York "Times" of Friday, March 19, it is stated that New York City is providing 140 gals. of water "for each inhabitant, although other cities do well with twenty, and fifty is almost a maximum."

Statistics of water consumption in 176 of the principal cities (submitted to the "Times" but not published or acknowledged by it) do not bear out that statement.

In 111 cities, all having a population of over 25,000, the consumption was as follows:

Over 300 gals. per capita per day	2
From 200 to 300 gals. per capita per day	6
From 100 to 200 gals. per capita per day	42
From 50 to 100 gals. per capita per day	53
Under 50 gals. per capita per day	8
Total	111

The highest rate for any city was 324 gals.
The lowest rate for any city was 31 gals.
The average rate for all was 105 gals.

In 65 cities, all having a population of less than 25,000, the consumption was as follows:

Over 100 gals. per capita per day	6
From 50 to 100 gals. per capita per day	31
Under 50 gals. per capita per day	28
Total	65

The highest rate for any city was 149 gals.
The lowest rate for any city was 10 gals.
The average rate for all cities was 61 gals.

The average consumption for the entire 176 cities, large and small, was 89 gals. per capita per day.

Yours very truly,
Walter M. Smith, Sr.,
Civil Engineer.

489 Brooks Ave., W. New Brighton, N. Y., March 30, 1909.

A Poker Problem for Calculators.

Sir: In a late daily newspaper there appeared a paragraph telling that in a certain five-handed game of poker there occurred a deal wherein each hand got a pat full as follows: Eight full, seven full, six full, five full and four full. It was claimed that this was a square deal "because the dealer was above suspicion; and particularly because he himself had the smallest of the hands."

This was certainly a surprising deal and it does not occur often as humanity measures time; but whenever it does occur we immediately have four players, out of the five concerned, unanimously agreeing that it occurs too often.

As to the probabilities of this occurrence we have:

The possible number of different poker hands that are contained in a 52-card deck is 52_5; meaning 52 characters in 5-place combinations.

$$52_5 = \frac{52.\ 51.\ 50.\ 49.\ 48}{1.\ 2.\ 3.\ 4.\ 5} = 2{,}598{,}960.$$

The possible number of each of above fulls, taken singly is

$$4_3 \times (8 \times 4_2)$$

meaning, say, 4 eights in three-place combinations, times 8 denominations of 4 cards each in two-place combinations (the three of the fulls employing 5 of the 13 denominations, leaving 8 denominations of 4 cards each to form the pairs to complete the fulls).

$$4_3 \times (8 \times 4_2) = \binom{4.3.2}{1.2.3} \times \left(8 \times \frac{4.3}{1.2}\right) = 192$$

Taking next the 52_5 possible single hands in combinations of 5 hands each, we get combinations of combinations as follows:

$$52_{5_5} = \frac{52_5,\ 47_5,\ 42_5,\ 37_5,\ 32_5}{1,\ 2,\ 3,\ 4,\ 5}$$

whose log = 27.3947.

And for the possible number of combinations of combinations for the said 5 fulls we have:

$$\frac{(4_3 \times 8 \times 4_2) \times (4_3 \times 7 \times 4_2) \times (4_3 \times 6 \times 4_2) \times}{1 \quad \times \quad 2 \quad \times \quad 3 \quad \times}$$
$$\frac{(4_3 \times 5 \times 4_2) \times (4_3 \times 4 \times 4_2)}{4 \quad \times \quad 5}$$

whose log = 8.6493. This where no two of the fulls have pairs of the same denomination.

Thus we finally have log 27.3947
log 8.6493
log = 18.7454

which gives the number 5,560,000,000,000,000,000 as the number of deals out of which only a single one will be the hand described.

Now, and sad to relate, these figures, added to the heathen Chinee-esque peculiarity of the said deal, may encourage some mean-spirited poker-player to infer, imply, or perhaps even say, that the probabilities are, similarly, one in five thousand five hundred and sixty quadrillions that the dealer was honest.

William Hoffman.

20 Vaughan St., Boston, Mass.

A Lawsuit Over a Contract for Building an Embankment.

Sir: A case recently decided by a West Virginia court presents some points of interest to all having to do with engineering contracts.

The circumstances leading to the suit were as follows: In June, 1907, the County Commissioners or County Court (afterwards the defendant in the suit) employed an engineer, A, to estimate the amount of earth required to make an embankment across a hollow. He estimated the amount from the profile at 22,000 cu. yds.

In September following he was employed to prepare plans and specifications for a masonry culvert and earth embankment. All papers were drawn by him and all proceedings conducted in the usual way till the award of the contract. He then cross-sectioned the work for use later in making up estimates, especially the final one, and set slope stakes. This was done by Oct. 8. About this time the papers were removed from the courthouse and rewritten, omitting some of the specifications. As thus changed the contract was signed Oct. 12. Among the changes was the substitution of the County Surveyor, B, for engineer, A, so that the contract defined the engineer as B "or his assistant satisfactory to the County Court." B was referred to *by name only* and not as a county officer. The first estimate was made out and signed by B. The second was made out by him and signed by the Deputy County Surveyor C as Assistant to B. B then died. C was appointed County Surveyor and by tacit consent of both parties assumed charge of the work and made out the remaining estimates 3 to 7.

The early estimates made out were based on the number of cars dumped as reported by the contractor. In March, 1908, the Court became alarmed at the amount already paid out and called upon A to explain his preliminary estimate. The specifications stipulated that earth should be measured and paid for "in position in the embankment," and A recommended that attention be directed to this clause in making up the estimates. At this point A was requested and urged to take charge of the work again, but refused. It developed that B had never cross-sectioned the work. Thereupon A furnished C with the notes, as he had been paid for all his work, including the cross-sectioning. The last two or three estimates were then made by C using A's notes. The contractor objected to final estimate and claimed about 10,000 cu. yds. additional, amounting to $7,500; but he came back and took the money and receipted for estimate No. 7, which purported to be a final estimate. Closely following payment of this estimate contractor sought a compromise, and then arbitration, but both were refused. Suit was then brought. A was employed to examine and measure the work. He found that the contractor had been overpaid $900. Though C had used A's notes in making up the final estimate he had assumed the roadbed to be up to grade and also had made no deduction for the culvert 213 ft. long and having an outside cross-section of 42 sq. ft.

In the trial the defendant sought to exclude testimony tending to show the number of cars dumped and the method of keeping the record. The court admitted the evidence, however, on the theory that B had not made the measurement in the manner provided for in the contract, hence the contract could not be carried out in that respect. Plaintiff could, therefore, show by any method, usual or unusual, how much material was furnished. For the same reason the defendant was allowed to introduce the testimony of A showing the amount of fill to be 21,615 cu. yds. measured "in position in embankment" as provided in the contract, though he was not the one designated by the contract to make the measurement. Of course each side then sought to discredit the method and accuracy of the other. The question turned more on accuracy, it being admitted that the cross-section method is the usual one.

The court held that estimates 3 to 7, which were made out and signed by C, were irregular, that is, not in accordance with the contract. Though C had been assistant to B he was no longer so after B's death. Death of the principal terminates the agency. However, estimate No. 7, purporting to be a final estimate, having been allowed and paid by the defendant and accepted and receipted for in full by the plaintiff, the same was binding on both parties unless it could be proved that there was fraud, mistake, accident or omission, and the burden of proof rested on the party seeking to set aside the transaction. Each side claimed mistake in favor of the other.

There were other complications in the case not brought out in the trial and not necessary here. At the end of a five-day trial the jury returned a verdict for the defendant.

The main point of interest to those called upon to draw engineering contracts is the ruling about the engineer who died. Where a chief engineer of the company or the city engineer or other officer is designated as the engineer without designating him as an individual there would be no difficulty in case he died, for his successor in office would answer the description of the engineer set forth in the contract. But where an individual is designated by name as the engineer or architect, it would seem wise to provide in the contract how his place should be filled in case he dies, becomes insane or otherwise incapacitated. If this is not done, matters which should be settled by him may come up on disagreement and have to be settled outside the contract, like the measurement of earth in this case, and methods may be introduced contrary to custom and contrary to the previous understanding of the parties. A contract should provide for binding the parties in every contingency that may arise; but as ordinarily drawn, the clause defining the engineer leaves a large opportunity for trouble if the man dies. The clause in regard to his assistants breaks down in case of death or any cause that terminates an agency of that kind.

The ruling that a settled account evidenced by a receipt in full may be reopened and corrected in case of proof of fraud, mistake, accident or omission is not new, but is often overlooked. The fact that the burden of proof rests on the one seeking a revision should not make either party careless of the items of a final estimate. Both parties in this case were grossly careless. The plaintiff accepted the estimate knowing it to allow far less than the amount claimed to be due and the defendant paid a final estimate without securing a release under seal from the contractor for all further claim whatsoever, as the contract provided and knowing of the claim for a large additional amount.

Finally, it may have occurred to the reader already that the case gives added force to the old adage about trading horses while crossing a stream.

"A Witness."

Feb. 26, 1909.

[We may add that the case also shows that it is cheaper to employ a competent engineer from start to finish of a piece of work than to attempt to economize by turning over the responsibility to a cheap man after the plans are made.—Ed.]

More Concerning "Professorial Researches."

Sir: The editorials and reviews in your paper are in general so fair and unprejudiced that the publication of one which has neither of these qualities calls for comment. In the editorial of March 11th, entitled "A British Professor's 'Research' in Steam Boiler Design," the writer, in endeavoring to be witty, misrepresents the conclusions reached in said paper. Without attempting to support any of said conclusions or the analysis by which they are reached, it is only proper to call attention to the fact that none of the results mentioned in your editorial would follow from the use of such high drafts, when applied in accordance with the principles laid down.

The carrying of fine fuel through the boiler and up the stack is due to excessive air velocities through the fuel-bed and the combustion chamber; if the present usual rates of combustion are adhered to, no more coal would be carried up to the heating surfaces than at present, and the use of an excessive draft as recommended to force the gases at high velocity through constricted flue passages would result only in carrying out through the stack the small amount of cinders which would otherwise be deposited in the soot chambers or the bottom parts of the passes of the boiler. Any recommenda-

tion that such excessive drafts should be applied to existing designs of boilers would, of course, merit the comments in your editorial, but the most superficial reading of the paper makes it clear that no such interpretation was ever intended.

Inasmuch as so much stress is laid in the paper on the necessity of distinguishing between a high rate of combustion and a high velocity of the products of combustion through the flue passages, it is evident that your editorial was written by some one who had hardly read the paper once through, much less endeavored to follow the reasoning. There could be no motive for intentional misintepretation, and the weight which is usually accorded the utterances of your editorial columns should induce you to re-read the paper and publish a more intelligently considered discussion of the subject. The well known work which has been carried on by the Fuel-Testing Department of the Geological Survey reaches similar conclusions, but points out the commercial limitations more clearly, and there is ample opportunity for a calm review of this very important subject.

Respectfully,

"B."

Havana, Cuba, March 23, 1909.

Sir: Your comments in your March 11 issue on Professor John T. Nicolson's paper on "Heat Transmission in Steam Boilers" have been read with interest, as also the original paper and the editorial comments of "Engineering," which are along somewhat the same lines.

It would seem, however, that the editors are discouraging the professors unnecessarily. Engineers should rejoice that professors have the time, leisure and means for carrying on such scientific researches, which are impossible, or at least neglected, under commercial conditions. Such researches may appear futile from the point of view of standardized practice, but they may nevertheless be justified by future developments. Take the present case, for instance: Although Professor Nicolson's formula is cumbersome, it is equally certain from recent investigations that the transmission of heat from a circulating gas to water within a metal surface is not entirely, or nearly, as the square of the difference of the temperatures, as stated by Rankine. In fact, recent experiments seem to show that it is directly as the difference in temperatures, as given in Professor Nicolson's formula. It should be noted that neither formula applies to heat received by the boiler surface by direct radiation from the incandescent fuel bed, which follows still another law.

Also in criticizing Prof. Nicolson's proposed draft of 10 to 20 ins. water gage by suggesting that it would lift the fuel from the grates, are you not confusing the total draft with the actual drop in pressure through the fuel bed? It is quite possible to build such a boiler that 10 ins. of draft would be consumed altogether while the draft through the fuel bed would not be greater than ordinary.

To illustrate the effects of velocity and turbulence upon the transmission of heat between gases and metal surfaces, I will quote from some tests upon the Green waste heat air heater, a device similar to the economizer but arranged for the circulation of air instead of water through the tubes. It was found, for instance, that when 40 cu. ft. of air per minute were passed through each pipe in the heater, slightly more than 1.3 British thermal unit was transferred to the air per sq. ft. of heating surface per hour per degree F., average difference of temperature, and when half the tubes were placed in series with the other half, the transmission was increased to nearly 2.5 units per hour, while with winged spirals in the pipes to break up the currents of air and increase the turbulence the transmission became nearly 3 units per sq. ft. Now, referring to the corresponding drafts, we find that the pressure required to force the air through the heater was less than 0.5 in. water gage in the first place and over 4 in. water gage in the last. By analogy therefore, it is possible so to arrange a boiler that the transmission per sq. ft. and the draft required to draw the air through the boiler would be tremendously increased, whereas the draft through the fire might not be in anywise altered, and under such conditions we would have a much higher heat transmission per sq. ft. of boiler surface, a highly desirable feature in modern crowded boiler-rooms in which the "intensive cultivation" of space is so profitable.

These high drafts may be at the present time too expensive to produce, especially with our present commercial mechanical draft fans having a mechanical efficiency of from 30 to 49%. However there is no doubt that better fans will be built for this purpose, especially in view of the fact that mining fans are now constructed which test up to 70 or 80%. Improvements can also be made in the efficiency of the driving engines and, in any case as long as the exhaust of the latter can be used to aid in preheating the feed water, the steam consumption is immaterial. It is apparently such considerations as these, combined with exhaustive experiments, that have led certain Government engineers to commit themselves to statements as revolutionary as those of Professor Nicolson's, viz.:

The experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers. These increases require about double and treble the quantities of air to be put through the fuel beds and boilers. It also seems possible that rebaffling the boilers will often permit the capacity to be doubled or trebled, while still getting more steam than formerly per pound of coal for uses outside the boiler room. * * *

An important part of the discussion relates to an increase in the capacity of boilers by increasing the amount of power applied to pressure and exhausting fans and thus forcing several times as much air through the fuel beds and boilers.

It may be possible, as a result of these investigations, to raise the rate of working the boiler heating surface to three or even four times its present value. Such an increase would undoubtedly mean new designs of grates, stokers, furnaces, and boilers, especially fitted for high rates of working. Fan equipments designed to supply three or four times as much air under several times the pressure would be provided with more efficient engines, thus giving an additional factor favoring high-capacity working.

Very truly yours,

Geo. H. Gibson.

Tribune Building, New York City, March 17, 1909.

[We did not attempt in the editorial criticised to discuss the merits of the question, for it seemed to us Prof. Nicolson had so signally failed to connect up his "research" with practical engineering work that discussion was not worth while. Those who have given any thorough study to steam boiler problems have long known that the rate of heat transmission increases with the velocity of the hot gas currents over the surface. Those who do not know this are not likely to learn the fact when stated in the abstruse mathematical terms adopted by Prof. Nicolson.

As for treating the draft required to overcome the friction of the fuel bed separately from that required to overcome the friction through the flues, that, of course, is perfectly permissible; but if that is what Prof. Nicolson meant by his 10 to 20 ins. of draft he ought to have said so, otherwise some confiding inventor may be sadly misled in his experimenting. It might also have been well to have given some idea of what a draft of 10 to 20 ins. of water means in ft. per second of flue gas velocities. That high velocities are necessary to develop high *capacity* in a boiler has been well known for two generations, but that high velocities "should always be employed for really economical working" as Prof. Nicolson declares, is contrary to all accumulated experience.

Our chief object in the editorial referred to was to emphasize the necessity of checking the deductions from laboratory experiments and intricate mathematical processes with sound common-sense and clear understanding of practical considerations. We have seen many cases where this necessity has been ignored, and in every such case the "research" has been quietly buried and has had no effect whatever on practice.

Such work, moreover, is not harmless. These useless "researches" needlessly swell the volume of engineering literature, and lead practical business men to distrust engineering and engineers. The unfortunate youths trained under such teachers are started out in their professional work handicapped with wrong ideas and unpractical methods.—Ed.]

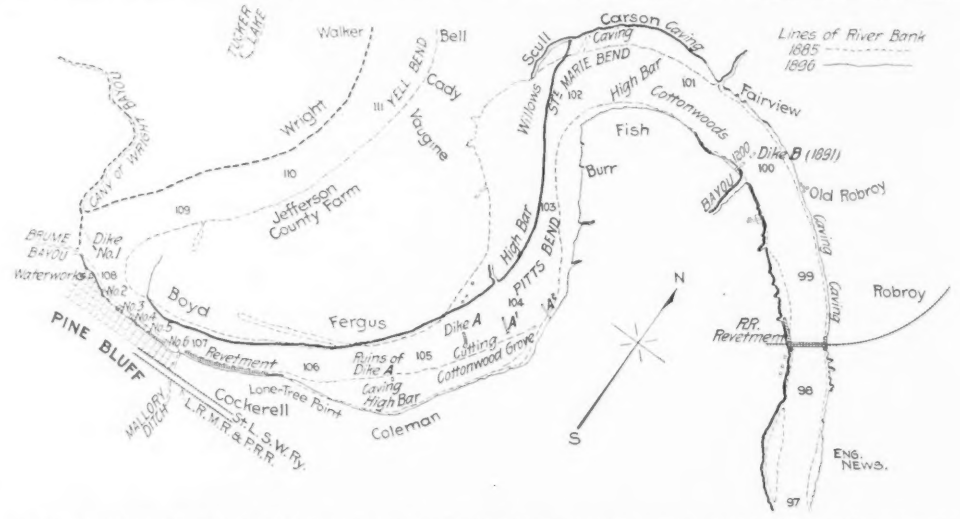


FIG. 1. MAP OF THE ARKANSAS RIVER, NEAR PINE BLUFF, ARK., SHOWING COMPARATIVE BANK LINES IN 1885 AND IN 1896.

Experience with Dike Protection of River Banks at Pine Bluff, Ark.

Sir: Referring to the communications of myself and Mr. Miller in your issue of Jan. 14, I wish to say that the cost of the two pieces of work at Eliza Point and Bird's Point is a minor matter, although my data as to costs of the Bird's Point work were obtained from a clerk in the offices of the railroad paying for the work, who held a position giving him access to the information. The information as to the cost of the Eliza Point work came from the U. S. Engineer Office at St. Louis, and covered only the work done between 1884 (erroneously written 1881 in my previous letter) and 1904, both inclusive. It did not include any of the previous work, which was of no help nor value to the improvement. My figures on the Bird's Point work were from 1888 to 1905, both inclusive. As the figures were given me, the Bird's Point work cost about 7% more than the Eliza

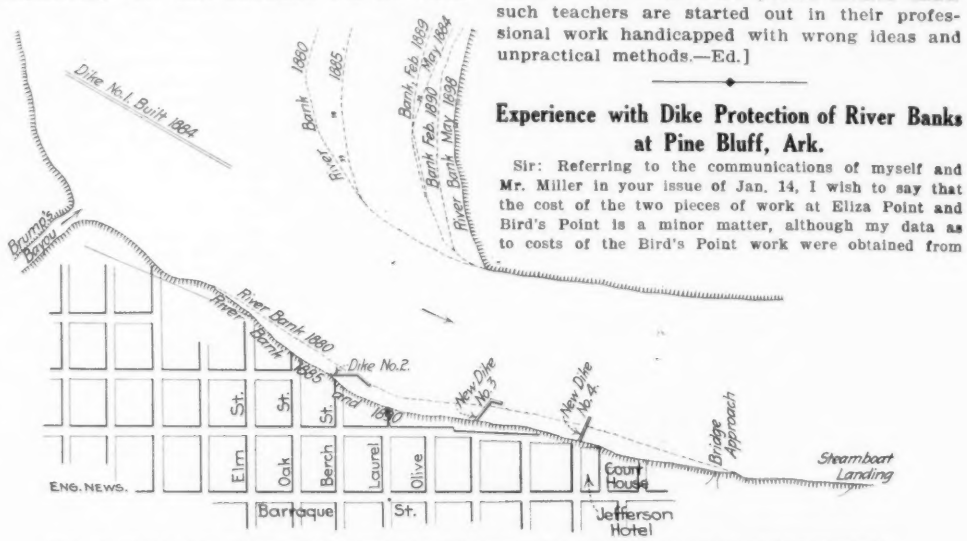


FIG. 2. MAP OF RIVER BANK AT PINE BLUFF, ARK., SHOWING DIKE PROTECTION.

Point work. Any one interested can study the matter at first hand by visiting Cairo.

The vital thing is that the failure of the work at Bird's Point began with the David Neale work, and its failure left the other work open to attack in the weak place. It seemed that the Neale system was given

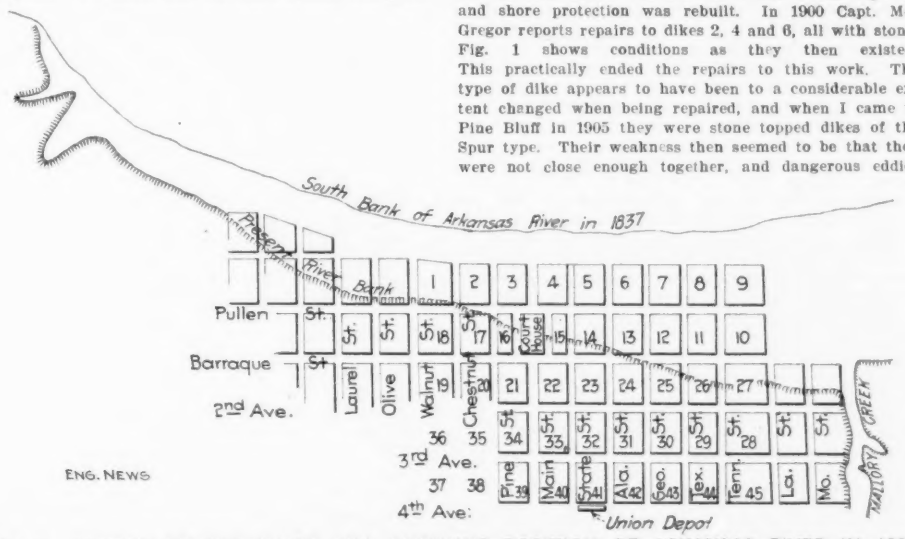


FIG. 3. SKETCH OF PINE BLUFF, ARK., SHOWING POSITION OF ARKANSAS RIVER IN 1837 AND IN 1909.

a trial with few restrictions on the cost, and it did not make good.

Referring back to the work at Pine Bluff, perhaps a little history may be of interest. I was at Pine Bluff the winter of 1884-5 when the work was being done which called for the "Lion Hearted Constructor." Coming as I had from work on the Wisconsin and Missouri rivers, the work did not impress me as calling for so strong rhetoric as was used. It was difficult, but no man can work at river control without encountering difficult problems. At that time some dikes were being put in, made of brush and weighted with boxes filled with sand. During a rise the previous year the river cut badly on the town front, and the people had raised the same clamor which was raised this season for a cut-off at the neck. (Bell to Scull on map, Fig. 1.) In 1881 the front was protected by 3,900 ft. of revetment of a type then being experimented with, which is described in Senate Ex. Doc. No. 67, 46th Cong., 2d sess., which had failed to restrain the river, and Major Adams had recommended the abandonment of the mattress and adoption of what he termed the "Jetty Type" of protection. This report was made March 7, 1884, and the following winter Capt. Taber, who had succeeded Major Adams had three dikes built, and the succeeding year built two more. These are described in Appendix V., Report of Chief of Engineers for 1885. Major Taber in 1886 reports that no further work was done, that the river was itself protecting the banks, and that "The Arkansas River is effectively under control." In 1889 a new dike was built, and dike No. 3 was repaired. Fig. 2 enclosed shows the condition of affairs at that time. Note the type of dike then used, slanting down stream, with an L at the end continuing down stream. In 1892 dikes 5 and 6 were built, 4 was made into a rock dike, and 3 partly so. A, A', and No. 2 were partly repaired. In 1893 dikes 2, 3 and 4 were made stone capped dikes and revetment was put in below Mallory Creek. In 1898 dike No. 2 was repaired and shore protection was rebuilt. In 1900 Capt. McGregor reports repairs to dikes 2, 4 and 6, all with stone. Fig. 1 shows conditions as they then existed. This practically ended the repairs to this work. The type of dike appears to have been to a considerable extent changed when being repaired, and when I came to Pine Bluff in 1905 they were stone topped dikes of the Spur type. Their weakness then seemed to be that they were not close enough together, and dangerous eddies formed below all below No. 1, which eddies eventually led to their destruction. During the winter of 1906-7 the writer made plans for protecting the river front and reclaiming a site for railroad terminals at this point. A company was organized to undertake the work, and surveys and plans were made.

The first work of this type, reclaiming a yard from a river, which the writer saw was done by the Burlington Railroad at Plattsmouth, Neb., many years ago. It is described in Van Nostrand's Magazine about 1878. Not having a file of that publication, I cannot give exact date. Numerous yards have been made at other points, and the work has seemed to need only money, grit and intelligence. It needs enough money to do the work in a thorough manner at first.

Assistant Engineer.

Pine Bluff, Ark., Feb. 12, 1909.

The Destruction of a Pier of the Arkansas River Bridge and Other Instances of River Bank Erosion.

Sir: That portion of the report of the Waterways Commissioner of Wisconsin which you reprinted in your issue of Jan. 28, 1909, p. 91, is unquestionably of much interest to those endeavoring to understand the problem of waterway transportation and the economical improvement thereof. Your comments thereon, in the same issue, p. 106, are extremely well taken, and very much to the point. It is not difficult to understand that Mr. Reid has considered and investigated his subject from the view-point of the sane and practical business man; and although we may question some of his detailed statements, we believe it to be impossible successfully to disprove any single one of his enumerated conclusions, provided we are required to apply only sound business principles.

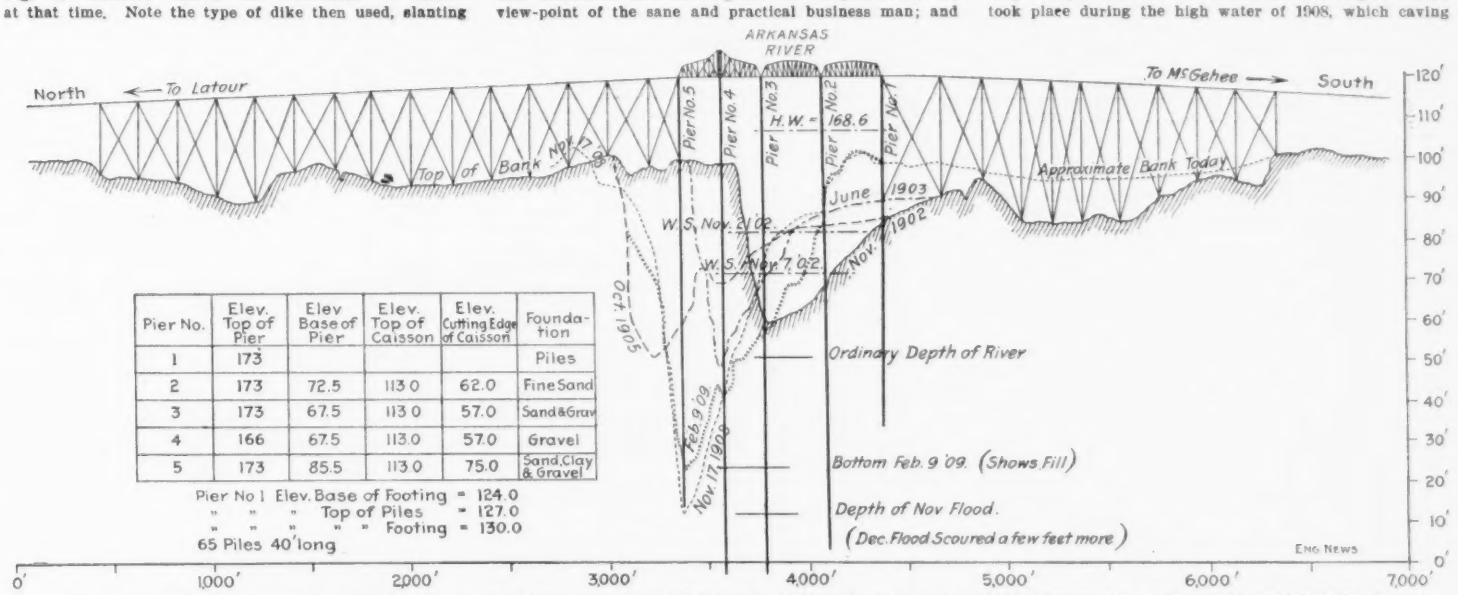
We should all take heed of his remarks, which you quote, regarding the difficulty of understanding the unreliability of much of the information that is volunteered; and his surprise at the difference between the actual conditions, and what he had supposed them to be; also his concern about giving to the public information before he had personally examined the question involved.

Although the writer is in entire accord with the second conclusion of Mr. Reid, viz., "The Mississippi River below the mouth of the Missouri is practically incapable of any improvement, except at a cost far in excess of the actual value of such improvements," he cannot accept the citations given as being sufficient evidence upon which to base this conclusion; in fact, Mr. Reid may have given them only to show that it is difficult and expensive to hold a river bank composed of such light material. In any event, it seems that this part of the report could very easily be misunderstood, and as the writer is more or less familiar with the history and details of the works mentioned, he will endeavor to explain briefly the same and show that the works were placed primarily for the protection of private interests and not for the improvement of the river proper, and that those interests are of such importance and value that it would have been economy to have spent, at the proper time, a sufficient amount of money to have prevented the destruction which resulted. It is admitted that the works, considered solely upon the basis of their improving the navigable channel, could not have been figured as justifiable from a business point of view.

THE BIRD'S POINT CASE.—In the discussions of the different methods of river improvement works, in Engineering News during recent months, some facts were given concerning work at Bird's Point, Mo., but it seems necessary now to go more into the details of that work. It appears that at one time the Iron Mountain Ry. and the Cotton Belt Ry. each maintained an incline and a transfer at this point. Some eight or more years ago the Mississippi River began attacking the bank in the bend just above the Iron Mountain incline (which was a thousand feet or more up stream from the Cotton Belt incline); the Iron Mountain Co. then took measures to protect against the encroachments, but in a haphazard way, dumping in considerable riprap and mostly at the point just above the incline. Finally a contract was let to David Neale for some fascine dikes, which he built. We find between $6,000 and $7,000 charged on the books of the company against this work, but assume that they must have spent about twice that amount. In 1904 the Government placed about 2,000 lin. ft. of standard revetment work above and partly lapping over the David Neale work, at a cost of about $16,400, giving a total of about $30,000 expended for river protection.

Several years ago, the Iron Mountain Ry., having previously taken up with the Cotton Belt Ry. the question of aiding with the protection work but without reaching a satisfactory agreement, abandoned their incline and front line, and connected up with the Cotton Belt tracks above the danger zone, continuing their transfer but over the Cotton Belt incline.

After about 1905 no repairs nor additions of any kind were made to the partial protection works, and after holding through one or more subsequent high waters, they finally succumbed and a maximum caving of 800 ft. took place during the high water of 1908, which caving



Pier No.	Elev. Top of Pier	Elev Base of Pier	Elev. Top of Caisson	Elev. Cutting Edge of Caisson	Foundation
1	173				Piles
2	173	72.5	113.0	62.0	Fine Sand
3	173	67.5	113.0	57.0	Sand & Grav
4	166	67.5	113.0	57.0	Gravel
5	173	85.5	113.0	75.0	Sand, Clay & Gravel

Pier No 1 Elev. Base of Footing = 124.0
" " " Top of Piles = 127.0
" " " " Footing = 130.0
65 Piles 40' long

PROFILE OF THE BRIDGE ACROSS THE ARKANSAS RIVER, MEMPHIS HELENA AND LOUISIANA LINE OF THE IRON MOUNTAIN RY.
(Showing the Effect of Floods and Scour on the River Bottom.)

extended to within a very short distance of the Cotton Belt incline and leaving the Iron Mountain incline over on the other side of the main channel. Even at this late time it was possible to have placed standard revetment work along this bank at a cost not to exceed $75,000, and when it was not yet too late to have saved most of the Cotton Belt facilities. The river soon fell, the caving checked up very much, no protection was authorized, and to-day there is very little left in place except the yard tracks, and they will soon have to be abandoned because the incline has about caved off.

A new location is now being considered for this incline, the yards and other facilities, entailing an estimated expenditure of not less than $150,000 for the building of the same.

A recent estimate of the actual face value of the different property of the two railways at this point amounts to about $125,000; this was not all lost, probably half was saved in tracks taken up and buildings moved back, but the labor cost of this moving amounted to a considerable sum. The above figure does not include the Iron Mountain incline abandoned several years ago. This estimate does not include anything for the right-of-way, or the worth of this terminal and these facilities as a necessary part of the railways running into the same.

In addition to the above-mentioned losses it became necessary, on account of the progress of the caving, to construct new levee loops, at some distance back from the location of the original levee (a part of the old embankment of the railway acted as the levee at one time). No complete figures regarding the cost of these new levees are at hand, but we know that one loop of nearly a mile in length contained over 100,000 cu. yds. In all probability, the expense of building this loop was fully $18,000.

These approximate figures (all on the safe side) show that it would have been quite economical for all interests to have gotten together and appropriated enough money to have saved their property.

THE ARKANSAS RIVER BRIDGE.—The next case cited by Mr. Reid is at a point about 20 miles above the mouth of the Arkansas River; this bridge is the crossing of the Memphis, Helena, and Louisiana line of the Iron Mountain Ry. The loss of the pier was not due to any recent caving of the bank, because several years ago the main bank had caved some three or four hundred feet behind this pier before the bridge was erected and after the pier had been built, but it was directly due to an unprecedented depth of scour, brought about, as is plainly evident now, by a contraction of the high water channel in an effort to hold and maintain a low water navigable channel under the draw span.

This bridge, as shown in the accompanying profile, consists of two fixed spans and a double ended draw (revolving on a center pier). Both the fixed spans are south of the draw. There are five pairs beginning at the south with No. 1. The pier lost, No. 5, was under the free end of the draw.

A combination of errors, some brought about in an effort to overcome an earlier one, led up to the present trouble. It is now quite evident that the original location of the crossing was wrong; but when made it was not so evident, although to place a crossing near the foot of a caving bend is generally conceded to be hazardous. The caving in this locality had not been so very active during the years immediately preceding the adoption of this location. However, during the season just previous to starting the construction of the piers, the caving cut the bank back about 200 ft. At this time considerable heavy grading had been accomplished for some distance both north and south of this bridge site, and although it was patent that the proposed bridge location was not a good one, it was deemed inadvisable to throw away the grade already placed, so the location for the bridge was moved north several hundred feet from where it was originally intended that it should be, and pier No. 5 was placed about 75 ft. back from the main bank line. The caving continued and when the time came to erect the superstructure the bank line was slightly over 300 ft. back from this pier, all of the low water was passing around north of the proposed bridge, and a sand bar existed under the location of the draw. It was necessary in order to avoid obstructing navigation to get a part of this flow under the draw span before the pile approach could be driven to connect or rather bridge the space between the main bank and the end of the draw so deflection and contraction works were constructed. It would have been cheaper in the end to have built the necessary additional piers and moved the draw span north; failing to do this the only alternative was to deflect the river to the draw. Work under this plan was placed from time to time, much of it of the David Neale mud cell variety, until at the time of the recent floods there was scarcely any of the low water flow going under the pile approach, and the filling, in the old channel under this approach, was as much as 35 ft. in places. This river carries considerable drift during periods of high water; no drift fenders were constructed on the piers, and during the past two years a large drift pile accumulated above pier No. 3 being in effect also a contraction of the high water channel, but on the south side of the same.

A flood in the Arkansas during a very low stage in the Mississippi happens only once in a great while, and the recent floods, one in November and the other in December, 1908, were the first ones since the bridge has been built. The current at the bridge site becomes very swift at such times, as this location is near the mouth of the Arkansas River. Velocities as great as 10 miles per hour have been measured in this locality; and some as high as 13 miles per hour have been estimated. Such a current flowing through an alluvial soil causes rapid caving.

Mr. Reid states that this pier was sunk to a depth of 50 ft. below the bottom of the river. Although this is true regarding piers Nos. 3 and 4 it was not the case with this pier No. 5, which was stopped at an elevation of approximately 18 ft. above the base of the piers Nos. 3 and 4. It can hardly be considered, under the conditions then existing, as anything but poor policy to have stopped this pier before it reached as great a depth as any other pier in the structure, because this pier was located just beyond the deepest part of the river and at a point towards which the caving was rapidly progressing. It is true that the maximum scour that might occur was assumed at about 81 ft. below the assumed base or rail, and that even this pier No. 5 was sunk to 25 ft. below this scour. (See Figure.)

The actual scour during the floods in question was about 110 ft. below base of rail, going below the bottom of this pier and causing it to topple over. The river is again filling in at this point, and no doubt this fallen pier will eventually be entirely covered over and be situated below the ordinary bottom of the river.

A survey made shortly before the flood of November, 1908, developed the fact that, at a point about 100 ft. down stream from pier No. 5, the river had scoured down so that the elevation of the bottom was approximately 10 ft. above the elevation of the bottom of the pier; it was feared that this scour might progress up stream at the next high water and weaken the stability of the pier, and a contractor had been asked to accompany the writer to this bridge and submit a bid for mattress work to protect the foot of this pier, upon the assumption that high water would not occur for several months at least, but about this time the river went to flood stage at Fort Smith (being several months ahead of its usual time), and the passing of this flood caused the loss of the pier.

It is not very hard at this time to point out a number of precautionary measures either one of which, had it been taken at the proper time, would undoubtedly have saved this loss at an expense which would not have been prohibitive. For instance to have built this pier from a depth 18 ft. lower would have cost about $6,000 additional, or to have placed a willow mattress 200 ft. square on the bottom of the river around the pier would have cost about $4,000. So therefore while the railway company is being put to much expense to hold its position, it is hardly fair to cite it as a general case of unreasonable expenditure, when by the use of some well-known effective measure at a nominal cost at the right time the large expenditure would have been saved.

The other case cited by Mr. Reid is that of Pine Bluff, Ark., which needs no further explanation than is given in the article you published in the same number that contained the report of Mr. Reid, p. 103, and in which you quoted from a letter by Major Walker, Corps of Engrs., U. S. A.

Yours respectfully,

Chas. H. Miller,

Engr. River Protection, Missouri Pacific Ry. Co.

Little Rock, Ark., March 8, 1909.

The "Type Characteristic" as a Criterion of Water-Wheel Runners.

Sir: I desire to offer a little friendly criticism of the article entitled "A Comparison of American High-Speed Runners for Water Turbines" appearing in your issue of Jan. 28 last.

Your correspondent develops a constant, K_t, which he calls the 'type constant" or "type characteristic" of the runner, stating that it is a combination of the speed and capacity constants determining the type of the runner. I regard these statements to be misleading and erroneous. While it is true that turbines of the same type will have the same value for the constant K_t, yet it is not true conversely that turbines having the same constant K_t will necessarily be of the same type. For example, take a 65-in. wheel of the same type as a 12-in. Risdon Standard Cylinder and Register Gate Wheel of 5-in. vent. With slightly closed gate it would give the same performance, with reference to speed and power, as the Doble unit driving a 2,500-HP. generator in the Snoqualmie Falls plant. This latter unit is composed of six Doble double-nozzle wheels keyed to the same shaft, and develops 2,500 HP. at 300 r. p. m. under about 260 ft. head. Under these conditions the value of K_t for each of these units would be about 16, but it could scarcely be claimed that they were units of the same type.

Or, if it is inadmissible to consider more than a single runner, take one of the Fourneyron runners of the Niagara Falls Water Power Co., and the runner of the 10,000-HP. unit at Snoqualmie Falls. These single runners have practically the same value of K_t. Consequently proper sizes would give practically the same performance as to speed and power, but they are manifestly not of the same type.

Again, it is stated that "K_t is an absolute criterion for turbines in reference to the aim: Highest speed and highest capacity with good efficiency." This is quite incorrect. The quantity K_t is a coefficient of performance merely as to speed and power regardless of efficiency. I pointed out this fact to Engineering News nearly two years ago, and explained that a constant of performance involving speed, power, and discharge or efficiency could not be established until the three fundamental equations for speed, power and discharge were expressed in terms of another turbine dimension along with the diameter. This may be seen very plainly by examining the equations for speed and power in connection with the question: What must be the relation of the speed and power constants in order that we may have a turbine which will develop the power P at the speed N (r. p. m.) on the head h?

If n and p are the speed and power constants we have $N = nh^{1/2} \div d$ and $P = ph^{5/2}\, d^2$. The question then becomes one of pure mathematics, and its answer is obtained by extracting the square root of the second equation and multiplying the first by the result, which gives $n\sqrt{p} = N\sqrt{P} \div h^{5/4}$, thus eliminating d. That is, there is a value of d which will satisfy both equations (the requirements as to speed and power) at the same time. This quantity $(n\sqrt{p})$ is your correspondent's K_t. If now it were desired to have a constant involving the speed, power and discharge (or efficiency), it would be necessary to employ the third fundamental equation $Q = qh^{1/2}\, d^2$. Here q is the discharge constant and Q is the discharge. But to satisfy this and the first two equations simultaneously would require the presence in the three equations of two turbine dimensions which could be eliminated, whereas d is the only one.

In conclusion I may say that the square of K_t furnishes a much better basis of classification than K_t itself as employed by Mr. Zowski. For example, on this basis the coefficients of the Improved New American and the New Success would be 6,241 and 3,025 respectively. Hence a twin turbine of the latter would give about the same performance as a single wheel of the former because the indices (the squares referred to) are in the ratio of two to one. At my suggestion the square as the basis of classification was adopted by Professor Mead of the University of Wisconsin in an admirable treatment of this subject in a chapter of his "Water Power Engineering" published several months ago. A classification on this basis was presented in a paper by me read before the Engineering Section of the American Association for the Advancement of Science at Chicago in December, 1907.

B. F. Groat.

University of Minnesota, Minneapolis, Minn., Feb. 12, 1909.

[Mr. Zowski's reply to Prof. Groat's criticism follows:—Ed.]

Sir: Although there may be a difference of opinion as to whether "type characteristic" or "type constant" is the proper term for K_t, there is no real basis for such a difference as far as the interpretation of the character and value of this constant is concerned.

It seems that the reason for Mr. Groat's criticisms in the first part of his letter is mainly due to some misunderstanding as to the meaning of the word "type." Not to speak of the case where Mr. Groat compares a *turbine* type (six impulse-wheels on one shaft) with a *runner* type (radial-inward-flow), he thinks, in using the word "type," of various runner systems, such as Francis, Fourneyron, Impulse, etc. In connection with K_t, however, the word "type" is used also or rather mainly to indicate the various kinds—types—of one system, for example, the various types of radial-inward-flow runners, which were the subject of my study. And with the modern tendency in water-turbine practice, which is to build only radial-inward-flow turbines and impulse-wheels, K_t is practically used only as characteristic of the radial-inward-flow runner, in which capacity it has proved so valuable.

Suppose we have to design a turbine for a given head H in feet, a power H-P, and a speed n in revolutions per minute, we shall find first the value of $K_t = \frac{n \times \sqrt{H\text{-}P}}{\sqrt[4]{H}\sqrt{H}}$. This value will tell us not only which system of turbine could or should be used and whether a single or multiplex turbine is required, but also of which type the runner must be. Thus, if K_t is about 3, a single impulse-wheel will be used; if K_t is about 6, four impulse-wheels of the characteristic $\frac{6}{\sqrt{4}} = 3$ or two impulse-wheels of the characteristic $\frac{6}{\sqrt{2}} = 4.25$ can be taken; but in neither of the above cases could a radial-inward-

flow runner be built, K_t being too small. Only if K_t is between 10 and 85 is a single radial-inward-flow turbine possible. For higher values of K_t we have to use a multiplex turbine, with our present knowledge and experience. The value $K_t = 100$ would require a twin turbine with runners of the characteristic $\frac{100}{\sqrt{2}} = 71$.

But this is not all. The constant K_t gives us considerably more information about the type of the runners to be built. If the value is near the lower limit for radial-inward-flow turbines, namely 10, the runner must be of a pronounced low-speed and low-capacity type, with bucket angles which are probably smaller than 90°, with a height which may be as small as 1/30 of the runner diameter, and with a discharge or draft-tube diameter much smaller than the runner diameter. If K_t is about 35, the runner is of the medium-speed and medium-capacity type, with bucket angles of 90°, height about one-fourth of the diameter, and draft-tube diameter nearly equal to the runner diameter. If K_t is near the upper limit, say about 80, the runner will be of a pronounced high-speed and high-capacity type, with bucket angles larger than 90°, height about one-half the diameter, and draft-tube larger than the runner diameter, therefore requiring a runner bulged out in profile.

So K_t gives us quite a good deal of information about the "type" both of the turbine and the runners which must be built for given conditions. In addition to this, K_t is for the experienced turbine designer a very reliable guide in making the final computation and layout of the runner, but to go into this matter here space forbids. No wonder, then, that K_t is used nowadays by all turbine designers abroad and is coming rapidly into practical use also in this country, as "type characteristic," no matter under which name it appears. It may be interesting to know that the Allis-Chalmers Co., of Milwaukee, has based the entire developing work of its standard turbine types, consisting of six different types of radial-inward-flow runners and two types of impulse wheels, on the quantity K_t, with excellent results.

This, I think, is sufficient to prove that the use of K_t as "type characteristic" is not "misleading"—at least not for a competent engineer. It is true that it does not decide with mathematical exactness whether in a given case six impulse-wheels or a Fourneyron or a Francis turbine or some other combination is to be used, but an engineer never expects or never should expect that mathematics will solve the problem for him. An engineer is not a mathematician; he has not only to solve equations, but also to choose and to decide.

In the second part of his letter, Mr. Groat criticizes my statement, that "K_t is an absolute criterion for turbines in reference to the aim: highest speed and highest capacity with good efficiency," and calling this statement "quite incorrect" he says that "K_t is a coefficient of performance merely as to speed and power *regardless of efficiency*."

Mr. Groat, no doubt, thought only of the one formula for K_t, namely $\frac{n \times \sqrt{HP}}{H\sqrt[4]{H}}$. Its other expression, namely, $K_t = \frac{60}{\pi} K_v \times \sqrt{K_q} \times \sqrt{K}$, escaped his attention, and because in the first formula only the speed and power appear, without the discharge or efficiency, he made his erroneous statement.

In deriving the second formula, I started out from the fundamental equations for the peripheral and entrance speeds. These equations hold only if the turbine is running with its "best" or "normal" speed and under normal conditions; hence K_t as used by me is valid only if the turbine is running with its normal speed and under normal conditions. And this must naturally be so, because otherwise K_t, like any other characteristic, would be absolutely valueless or misleading as basis for a comparison. Now if we compute K_t from the *normal* conditions, for which the turbine was designed and under which it shows the best efficiency, then K_t is a function of the efficiency, because then both K_v and K_q, which appear in the formula for K_t, depend on the hydraulic efficiency, since they both are equal to a constant multiplied by the square root of the hydraulic efficiency. Further, K, which also appears in the formula, is a function of the total efficiency. Another proof that K_t is a function of the efficiency is found in the fact that K_t is a speed. The *best* speed of a given runner is, as the fundamental turbine equations say, the higher in proportion as the hydraulic efficiency is higher; therefore K_t will have a higher value for higher, better efficiency, if we take (as we must) the best or normal speed of the turbine as basis.

So I must sustain my statement that K_t, used as I used it, is an absolute criterion as regards the aim of highest speed with highest capacity and good efficiency. It shows us without any doubt how successful the different turbine builders were in their aim of increasing the speed and capacity of their runners.

Finally, I fail to see why the square of K_t should furnish "a much better basis of classification than K_t itself," as I would fail to see why, for the classification of engines as regards their speeds, the value of the square of revolutions per minute should be taken instead of the revolutions per minute. It is scarcely to be assumed that the proposed basis could be deemed better only on account of the one fact that two runners together would have a constant twice as large as one runner of the same type, whereas in using K_t itself the constant of two runners would be the square root of two times that of one runner. Further, it could be scarcely believed that, if K_t were misleading, as Mr. Groat says, K_t^2 would be less misleading.

S. J. Zowski.

University of Michigan, Ann Arbor, Mich., March 5, 1909.

A Criticism of the Work of the Joint Committee on Concrete and Reinforced Concrete.

Sir: About four years ago the various cement and concrete interests throughout the country were requested to join a movement to secure a government appropriation for the experimental investigation of concrete and reinforced concrete. There were then many freak building ordinances in operation and the path of the reinforced-concrete builder was a thorny one so that any movement which, in the form of extensive tests and reasonably complete experimental data, would throw light on various forms of reinforced-concrete construction naturally would have been welcomed by those interested and commercially engaged in this line of business. For that reason this movement had the hearty support of everyone engaged in the reinforced-concrete line and numerous letters and resolutions were showered on senators and representatives at Washington to secure prompt and favorable action upon this appropriation.

As a result an appropriation of $100,000 was made for this purpose and, though several years have passed, from this appropriation there has been secured by those engaged in the business not five cents' worth of data which has been of any assistance whatever in conducting their every-day business. Not only have we this criticism of any tangible results for the expenditure of the money to offer, but we are now confronted by a report of the Joint Committee on Concrete and Reinforced Concrete* which, according to its own report in 1906, is in intimate collaboration with the "Structural Materials Testing Laboratory," the government office in charge of the administration of the $100,000 noted above, warning the general public of the dangers in connection with reinforced-concrete construction. The writer objects to a statement of this character since his experience as contractor or consulting engineer for contracting firms in the erection of five or six hundred acres of reinforced-concrete floors in all types of buildings, together with his experience through nearly twenty years' time in connection with structural steel construction has satisfied him fully that reinforced-concrete construction, properly designed and honestly executed with ordinary care, involves less risk in construction than putting up an ordinary structural steel frame of heavy timber construction. This view may be substantiated by securing the opinions of dozens of first-class, well-organized contracting firms, who have executed a large amount of this class of work. To them, as to the writer, danger in reinforced-concrete construction is synonymous with ignorance of proper design and lack of ordinary care in execution.

Is it any wonder that the Joint Committee on Concrete and Reinforced Concrete is considered somewhat in the light of a joke by many of those engaged in the reinforced-concrete industry? Is it any wonder that some of us who are commercially interested in this line of business, to whom it means our bread and butter, who are enthusiastic in our work, are inclined to discuss the work of this Committee in the frankest possible manner.

The men on this Committee, in no wise interested commercially in reinforced concrete, are selected to draw up rules for the men who are engaged in it personally, who are interested in it, who have the good of the industry at heart, who are staking every dollar they possess upon the stability of the construction they are putting up, and who are injured by every failure of those less skilled than themselves. These constructors propose to present to the public a construction which is at the same time safe to erect and safe to carry the guaranteed test loads, and which, in strong contrast with timber and steel, grows stronger and improves with age. They are accomplishing this result by the scientific combination of the two materials and by an allowance of working values commensurate with the advantage gained in point of strength and safety by such scientific combination, instead of endeavoring to attain safety by uniformly low values regardless of the character of the combination.

These men are supposed quietly to stand back and wait the dictation of a class of men having little or no practical experience in reinforced-concrete construction, whose interests are not entirely in the concrete line and some of whom, on the other hand, are largely tied up and associated with the types of constructions which concrete is replacing and whose business position is antagonistic to concrete. In view of the fact that it is the money of the general public that is being expended or supposed to have been expended in these investigations, these men on the Committee become responsible at the bar of public opinion for the results of the investigations which are supposed to have been made with the $100,000 appropriation of the United States Congress.

What do we get for our money? In commenting on the Committee's report in its issue of Jan. 28, 1909, Engineering News says (p. 106) that it is "the passing impression by a body of experts." Further (p. 111) "It has been known that very extensive testing has been carried on under the direction of the Joint Committee . . . naturally, therefore, one would look for a statement of progress, plans and present results." This would be true if the Joint Committee had ever made any investigation which would determine or disclose any facts not known to those engaged in this line of business 15 years prior to the formation of the Committee. In other words, the direct result of selecting men inexperienced and unknown in the commercial field of reinforced concrete has been the commencement of their investigation of forms long since discarded by the up-to-date constructor. It has taken them three years to get through with this stage of their investigation and in that time they have deduced no facts that are of any benefit to those engaged in this line of business.

The high standing in other engineering lines than reinforced concrete of some members of this Committee has caused those engaged in this industry to defer the publication jointly of their views as to rules and regulations for the safe conduct of reinforced-concrete work in order to give the Committee the courtesy of first presenting its views and of substantiating them by adequate test data. The minority members of the American Society of Civil Engineers' branch of the Joint Committee, although very likely interested commercially in the line of structural steel construction, have justified in a measure our confidence in their good sense by refusing to be drawn into this majority report and their following criticism of the general conduct of the investigation is nearly as severe as it is possible to put in English. They say:

> We do not consider the report as presented to be in proper shape for a document to be submitted to a society composed of engineers. As we understand the duty of your Committee to be, "to investigate and report," we are of the opinion that the report should consist of a dissertation on our investigations, with the conclusions derived therefrom. . . .

Although the Committee definitely calls the report a "Progress Report," the writer would like to make some specific criticisms of a few of its statements.

First, in the allowances on slabs: it is evident in these allowances that the Committee has never made a test of long span slab in a finished building, otherwise it would not have suggested the formula given. In an interview with a member of the Committee about a year ago the writer suggested that the most expeditious manner of securing test data would be to take a large number of buildings in different parts of the country and place test loads on the construction and determine the actual elastic behavior of the material in the completed building. Data as to the design, materials and execution could then be incorporated as a part of the report. The writer went further and offered to secure from the owners of a number of buildings permission to make such tests for scientific purposes. Such tests could have been made at a comparatively trifling cost. The objection against such a proposition was that while it would secure the desired information it would be liable to advertise some particular brand of cement, contractor or engineer that had to do with the construction and this would be an unpardonable sin.

The Committee's knowledge and comprehension of slabs is confined, apparently, to those of one way reinforcement while values four or five times as high as those stated may be used with an even greater degree of safety when using a scientific arrangement of the metal in the slab.

On what grounds does the Committee justify the assumption that the modulus of elasticity of concrete in compression within the usual limits or working stresses is constant? What experimental data has the Committee to prove that a floor slab reinforced over the support and not on the top throughout its full length can act as a continuous slab when one panel is loaded? Had it made any tests whatever of finished buildings this ridiculous formula would not have been given.

What data can it show as to the difference between the end span and the interior span? What test data can it show for the seemingly illogical distribution of steel in a rectangular panel as proposed?

Second, under columns. No test results whatever are

*For abstract see report of Annual Meeting of the American Society of Civil Engineers, Eng. News, Jan. 28, 1909, p. 111.

given under columns, the Committee merely guessing at the results that might be attained. If so, this surmise appears a wild one in the light of such experiments as the writer has seen conducted, The statement occurs that hoops or bands are not to be counted upon directly as adding to the strength of the column. As the writer has succeeded in adding from 40 to 50% to the strength of a column by a comparatively slight increase in the number of hoops he is curious to know upon what basis this conclusion was arrived at. The statement is made that at the end of 28 days 450 lbs. per sq. in. may be allowed on 2,000 lbs. concrete. In the writer's experience he has often dealt with 3,000 lbs. concrete at the age of 28 days would not develop 450 lbs. per sq. in. without reinforcement, so this allowance might readily lead to loss of life and disastrous results. The writer would not hesitate at all in allowing three times that value on the same concrete, well restrained by hooping and vertical steel.

No limitation is given as to the proper size for vertical bars in columns. It only says that large bars should be butted. What test data has the Committee on this subject?

This Committee recommends that the joint in columns be made flush with the lower side of the girders. If these are the only column joints, can it figure out a method of properly executing the work? The writer's experience has been insufficient to enable him to.

The writer will put himself on record as a concrete constructor as being opposed to any set of rules and regulations which are so indefinite as to render the working values dangerously high for inferior designs, thereby encouraging the use of improper details of construction. He is equally opposed to any set of rules which tend to bar the advancement of this excellent type of construction through ignorance of scientific methods of arrangement and he believes this to be the general sentiment of all first-class constructors in this field.

The foregoing criticism may perhaps be considered somewhat severe, but the writer believes it is justified fully in view of his notes as regards the experimental work done at St. Louis. He considers it justified in some measure by the talks he has had with members of this Committee. The role of the critic is not pleasant but it seems a necessary one in the development of an industry such as reinforced-concrete construction. Is it not time for the many men in this business who have had a fairly broad experience in the actual construction of this class of work to get busy? Is it not time for them now to form a "Do Something Joint Committee" composed of only the actual constructors in this field and draw up suitable rules for the safe erection and design of this important class of construction and formulate these rules on the basis of broad practical experience in this specific line of work and holding to those methods which have made concrete construction safe and reliable under their competent direction. Such men have in their possession a large amount of reliable data and ample opportunity to secure more at a comparatively slight expense. A combination of 50 or 100 of such constructors and the joint contribution of five hundred dollars apiece would enable them within six months' time to present a thorough and complete discussion of nearly all problems in the line of reinforced-concrete construction, which have not been properly dealt with by municipal ordinances in vogue today, and to secure the data essential to substantiate the conclusions arrived at.

Yours truly,

C. A. P. Turner, M. Am. Soc. C. E.

Phoenix Building, Minneapolis, Minn., Feb. 20, 1909.

Difficulties of Sea-Level Canal Construction in the Lower Chagres Valley.

Sir: In your able and convincing article of Feb. 25, entitled "The Reasons Why the Lock Plan for the Panama Canal Is Preferable to the Sea-Level Plan," you lay considerable stress on the difficulties to be encountered in the excavation of a sea-level canal between Bas Obispo and Gatun and more especially that part of the isthmus, wherein lies the lower part of the Chagres River, as well as a point near Ahorca Lagarto, called the "Black Swamp."

You further ask along this line, "Who knows how much material will flow back into the cut from the sides," etc?

The author, or his authority, apparently has entirely overlooked the fact that the first French Canal Co. practically completed their sea-level canal through that part of the isthmus in question or from Gatun to Pena Blanca, a small Indian village, near Bohio. The completed depth of channel was about 28 ft. wide, while the width varied from 150 ft. to 300 ft.

The visitor to this section may see, to-day, this portion of the French canal, stretching through a dense impenetrable jungle, with from 14 ft. to 20 ft. of water and with its banks still standing as straight and as little cut up from the Chagres floods and "torrential rains" as when the French dredges ceased their work in the latter part of the '80's. The greater part of the excavation was pumped but a short distance from the edge of the cut and most of the same may yet be seen, rising above the general level and covered with a dense vegetation.

The French canal and the location of any sea-level canal lies about two miles from the so-called "Black Swamp," with a high range of hills between. Without in any way discounting the stories that have been handed down from generation to generation, as to the wonderful things that have happened at this swamp, it is entirely safe to assume that the French Canal Co. encountered no difficulties worthy of the name in dredging their channel through this section, but, on the contrary, they in all probability encountered some of their easiest work. This is a matter of easy verification by the American and French contractors who performed this portion of the work.

Since about 1887 the Chagres River has flowed through the French canal between Pena Blanca and Gatun. It is, therefore, not at all strange that during this period, extending over 22 years, that more or less silting up of the channel has occurred.

With the great improvement that has been made in hydraulic machinery during the last twenty years, the excavation of the Obispo-Gatun section for a sea-level type would probably present no great or insurmountable obstacles.

There are good and sufficient reasons against the construction of a sea-level canal. They do not exist, however, on the Bohio to Gatun section.

Respectfully, R. W. Hebard.

Gorgona, Canal Zone, March 20, 1909.

[If our correspondent will re-read the editorial in our issue of Feb. 25, he will find that the old French Canal was there referred to as an object lesson of the silting which would take place in a sea-level canal through the lower Chagres Valley. We showed in a later issue that in the years from 1889 to 1900, by the estimates of the French engineers themselves, over 9,000,000 cu. yds. of sediment accumulated in the French ditch through the Chagres Valley and that on the Pacific side through the Rio Grande swamps.

Since our reference to the difficulties of a sea-level ditch in this location has been elsewhere misunderstood and misquoted, it may be well to explain more at length just what the situation is.

We fully appreciate that given time enough and money enough, a ditch with its bottom 41 ft. below sea-level could be dug through the Chagres Valley; but the point we emphasize, is that the difficulties to be met there are such that no engineer can predict with any reasonable degree of approximation how much time and how much money would be required. What *can* be seen is that a very large amount of both time and money would be necessary.

We asked the question: "Who knows how much material will flow back into the cut from the sides?" and we had in mind for one thing the experience of the Slaven dredges which dug the old French canal above referred to. It was common report among American engineers who visited Panama in the '80's, that some of these dredges at especially soft spots would stay anchored in one place for weeks, pumping out the soft material which sloughed back into the channel from the sides.

In any earth excavation for a canal prism, the slope of the sides must evidently be flat enough to be reasonably stable. Revetment of the sides to protect them against wave wash is of course out of the question. For much of the distance there is no suitable foundation to support revetment; and even if there were, it is cheaper to take out the material to a flatter slope than to attempt revetment. The slope adopted by the International Board of 1906 "in firm earth" was 1 vertical on 2 horizontal. In soft earth or swamp it is manifest that very much flatter side slopes would be necessary.

It is of course true that where a river or a tidal channel flows through a soft swamp, the sides of the channel are often quite steep; because the current is continually carrying off the sediment which flows in from the banks. The same thing does not hold in the dead water of a canal.

But the difficulties to be surmounted in building a sea-level ditch from Bohio to Bas Obispo, 14 miles, are much more serious than those below Bohio. On this upper section the banks would rise from 20 to 50 ft. above the water level, or a total vertical height of 60 to 90 ft. above the bottom. The estimate of 1906 showed about 12,000,000 cu. yds. of rock on this section of which about 7,400,000 cu. yds. was below sea level. Either this rock must be taken out by the slow and expensive processes of under-water excavation or else sections of the great ditch must be cut off by cofferdams, pumped dry and kept drained while the rock is being blasted and taken away. Nobody is wise enough to say within a long range, how much this would cost or how long it would take, or which process would be the cheaper. In fact, study by the engineers in charge of the work might very likely show that at some points work in the dry would be preferable and in others under-water blasting.

And the question what to do with the tributary streams on this section is one which would require vastly more study than was ever given to it. Dams would be required on many of these streams to control the flow, and no one knows what are the conditions on the sites of these dams nor what their cost would be. These streams as well as the Chagres itself would have to be controlled before work on the canal excavation itself could be advanced very far.

If this condition were ignored, the work would be often drowned out causing great delay and expense. Further, the streams would be constantly bringing in mud, silt and gravel to neutralize the work of the excavators.

It is fair to say that our correspondent apparently misunderstood our editorial to emphasize particularly the difficulties in sea-level canal construction in the swamps below Bohio. While we believe these would be very considerable, we also believe that they would be much exceeded by the difficulties to be met with from Bohio up the river to Obispo.—Ed.]

The Governor of Wisconsin on Water Power Franchises.

Wisconsin is one of the 37 states which have appointed conservation commissions within the past few months. In transmitting the first report of the Wisconsin Commission to the Legislature Gov. J. O. Davidson had the following to say on water-power privileges:

I desire to direct your special attention to what is said by the commission on the question of the conservation of the undeveloped water powers of the state. Since the organization of the state, the policy of granting franchises, under special acts, to individuals and corporations to dam our navigable streams, has been pursued. Such privileges, until 1905, contained no provision tending to protect the public, except the power to amend or repeal the acts. Since that time a provision has been incorporated in these acts providing for a forfeiture of the franchise rights for failure to exercise them within a limited period after they are granted, for a forfeiture in case of violation of law, and providing for the protection of the public in the prices to be charged for the sale of the power generated. These provisions, while valuable, do not, in my opinion, fully meet the requirements which the importance of the situation now demands.

The undeveloped water powers of our state are the most valuable of its natural resources. Their value is rapidly increasing with the advanced methods of transmitting power to long distances with but little loss of energy. Capital is fast seeking their control, and it is time now that the state should seriously consider the matter of the disposition and regulation of water-power rights; for, in a few years they will all be utilized, and it will be much more difficult then to formulate a system of effective control and regulation on account of the interests that will be affected. Industrial development should not be retarded, and the state should not desire to adopt a policy with respect to them, other than one which may aid, to the fullest extent, their development in the interests of all the people.

It has wisely been provided that our navigable streams and rivers shall be forever open to the free use of all the people of the state. No individual can acquire exclusive ownership of such waters. Our constitution prohibits the granting, by special or private laws, of corporate powers or privileges, except to cities. Some of our acts granting franchises to build dams come dangerously near, if they do not encroach upon, a violation of the spirit of the constitutional provisions referred to. In view of these facts, it seems the time has come when some system should be adopted under which all franchises to build dams on our streams should be conferred by general law applicable to all alike. Such provision would save much valuable time of the legislature, and a considerable item of expense to the state. I, therefore, recommend:

(1) That a general act be passed providing that the

granting of such franchises be placed in the hands of some state authority.

(2) That the powers of corporations receiving such franchise be carefully defined.

(3) That the conditions upon which such franchises may be granted by the state for such purposes be provided.

(4) That a small privilege or franchise tax be imposed on each horse power utilized, payable annually, so long as the power generated is used.

(5) That all acts granting franchises to build or maintain dams on navigable streams heretofore granted be amended so as to provide for their expiration at a fixed date in the future, with a provision that all persons and corporations exercising or holding such rights may comply with the general law in respect thereto, and thus bring all such franchise privileges under one general system, taking care in such legislation not to affect injuriously vested rights.

We have undertaken at great expense the establishment of a forestry commission, with a view of preserving such of our forests as remain, especially at the source or near the headwaters of our streams, and to acquire other lands, not suitable for agriculture, with a view of reforestation.

Preservation of our water powers goes hand in hand with forest conservation. The one is dependent upon the other.

It is but just, therefore, that the recipient of water power privileges contribute a small sum yearly to the forest funds.

Payments thus made will then be applied to the preservation of the property of those who pay the tax.

Julius William Schaub, M. Am. Soc. C. E.

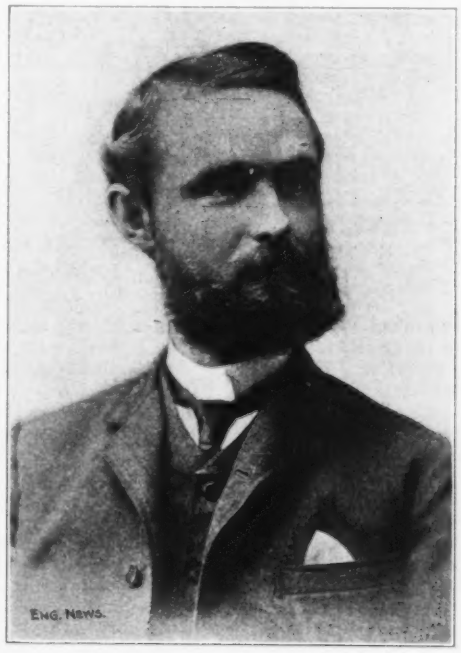
We briefly noted in our last issue the death of Mr. J. W. Schaub, of Chicago, widely known as a structural engineer. The news of his death came as a shock to a large circle of friends and acquaintances. Mr. Schaub had been in poor health for a long time. On one occasion he became unconscious on a suburban train and had to be carried from the car. A year or two ago he went to a sanitarium for a rest cure and treatment; this seemed to restore his health completely for a time; but recently he had again been suffering especially from sleeplessness and from some stomach complaint. He went to the same sanitarium, but did not take the treatment, and after a week's stay he telegraphed his family that he felt no better and would return. While on the train he shot himself, and death was practically instantaneous. According to report, he had shown much nervousness while on the train.

Mr. Schaub was born at St. Louis, Mo., on Sept. 23, 1859, and graduated from Washington University in 1881 with the degree of Civil Engineer. From 1881 to 1886 he was engaged with the late C. Shaler Smith, and was in this way connected with the design and construction of many important bridges. From 1887 to 1892 he was Chief Engineer of the Detroit Bridge & Iron Works. In 1893 he went to the Pottsville Iron & Steel Co. as Chief Engineer and Manager, and from 1895 to 1897 he held a similar position with the Hamilton Bridge Works, of Hamilton, Ont., Canada.

In 1898 he established himself in Chicago as a consulting engineer, engaging largely in bridge and structural work, and acted in this capacity for several important railways. With the development of reinforced concrete he devoted considerable attention to the use of this material for structural purposes, and employed it in several interesting cases. He had patented a reinforced-concrete caisson system for deep foundations (noted below) and a floor system in which each panel acted as a groined arch. He had designed also a reinforced-concrete roadbed for railways, with modifications for use on bridges and in tunnels, and this was described by him in Engineering News, Nov. 2, 1905.

In 1900 he was engaged by the St. Louis & Southwestern Ry. to report upon its bridges. He made a personal examination of every bridge on the system, and prepared plans for the strengthening necessary to adapt the bridges to the increased loads. In 1903, this railway took over a narrow-gage road in Arkansas which had a bridge crossing the White River at Clarendon, Ark. There was some question as to the stability of the cylinder piers under the increased loading, as there was no information as to their penetration. The method of strengthening devised and carried out by Mr. Schaub was to surround each old pier with a concrete caisson which was sunk to a greater depth than the old cylinders and became a part of the new pier. The two rest piers (for two fixed spans) consisted each of a pair of 6-ft. cylinders; both cylinders were enclosed in a new rectangular caisson about 12 x 38 ft. The pivot pier of the 355-ft. swing span had six 4-ft. cylinders arranged in the form of a hexagon and a central 6-ft. cylinder; these were all included in a 33-ft. circular caisson of reinforced concrete 18 ins. thick. The space within the rectangular caissons was filled with concrete, but that within the circular caisson was filled with sand.

Mr. Schaub was consulting engineer also for the new bridge of the same railway crossing the Red River at Shreveport, La., including both the substructure and the superstructure. This was commenced in 1904 and completed in March, 1907. It has four fixed spans of 200 ft., one of 150 ft., and a swing span of 300 ft. One of the notable features of this work was that the pier foundations were sunk to depths of from 60 ft. to 80 ft. by open cofferdams of reinforced concrete, on Mr. Schaub's patented system. He did



Yours truly
J. W. Schaub

a considerable amount of work for Mr. H. G. Kelly, M. Am. Soc. C. E., while the latter was Chief Engineer of the Minneapolis & St. Louis Ry., and later when he became Chief Engineer of the Grand Trunk Ry. One of Mr. Schaub's latest works was the design of a very large swing-bridge for the Grand Trunk Ry. at Black Rock Harbor, Buffalo, N. Y., to form a part of the International Bridge. This will have a length of 431 ft. 5 ins., and will carry two railway tracks and two roadways; it will be operated by electric power.

His work was not entirely in the line of bridges, however. In 1901, he was consulting engineer for the St. Louis, Iron Mountain & Southern Ry. in connection with the design and construction of its new shops at Little Rock, Ark. In 1903, he had a similar engagement with the Missouri Pacific Ry. for its extensive locomotive and car shops at Sedalia, Mo.; the plant included some 15 or 16 buildings, with a machine and erecting shop 752 × 135 ft.

Mr. Schaub became a Junior of the American Society of Civil Engineers in 1884, and was elected a member in 1886. He became a member of the Western Society of Engineers in 1901. He was a member also of the American Railway Engineering and Maintenance of Way Association, and of the Engineers' Club of Chicago. He wrote a number of papers for engineering societies and the technical papers, and took part also in many discussions on matters relating to his particular lines of study. His name has appeared many times in Engineering News in connection with articles and letters. We note some of his writings as follows: "The Detroit Union Depot Viaduct," Transactions of the American Society of Civil Engineers, May, 1893; "Proposed Specifications for Railway Bridges," Proceedings of the Western Society of Engineers, October, 1900 (and Engineering News, Oct. 11, 1900); "Diagram for Obtaining the Percentage of Steel and Moment of Resistance of Reinforced-Concrete Beams," Engineering News, April 30, 1903; "Some Phenomena of the Adhesion of Steel and Concrete" (from a lecture delivered at the Armour Institute of Technology), Engineering News, June 16, 1904; "Concrete Floors for Railway Bridges and Tracks," Engineering News, Nov. 2, 1905; "The Railway Track of the Past, and Its Possible Development in the Future," Journal of the Western Society of Engineers, May, 1907 (and Engineering News, June 13, 1907).

Mr. Schaub was married in August, 1893, to Miss Harriet Holmes, of Lock Haven, Pa. He had no children. Besides his wife, he leaves a sister (Mrs. Emma Rauch, of St. Louis). He was a man of brilliant attainments, experienced in the theory and practice of his profession, able and ready in discussion, and one whose ideas and opinions carried weight. The portrait which we present will seem somewhat unfamiliar to those who knew Mr. Schaub personally as it is from a photograph taken some 16 years ago; but we are informed that it was the last photograph taken of him.

Increasing the Life of Locomotive Crank Axles on French Railways.

The very extensive adoption of four-cylinder four-crank locomotives in France has resulted in showing the necessity of some improvement in the crank axles. Their cost is very high, and cracks in the webs or cheeks begin to appear after a relatively short length of service. Under these conditions, the railway engineers have been compelled to investigate the best design of crank axle in order to increase its life and to reduce the maintenance expenses of the locomotives. On the Western Ry. of France the following observations have been made on crank axles of the oblique type (as shown in Fig. 1) used on fast passenger engines.

(1) Of 13 ordinary axles of annealed open-hearth steel on locomotives of the 4:4:0 class, 10 were found to have cracks after runs of from 105,000 to 158,100 miles; (2) of 26 hollow axles from similar locomotives, three were found to have

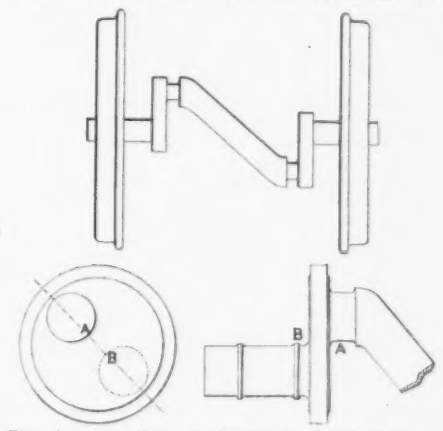


Fig. 1. Location of Cracks in Crank Axles

cracks after making runs of from 291,400 to 339,760 miles; (3) other things being equal, the crank axles of engines of the 4:4:2 class gave less service than those on engines of the 4:4:0 class, and on the former engines axles of an-

nealed open-hearth steel have developed cracks after runs of from 45,880 miles to 124,000 miles.

The axles crack always in the filleted angles A or B, Fig. 1, under the influences of the violent shocks in service, the dynamic effects of the shocks being concentrated at these points, where they cannot be absorbed by the elasticity of the metal. Permanent deformation is set up, and in time a crack appears; its development is often facilitated by defects in the metal, resulting from the segregation of metal in the ingot.

In order to avoid the formation of these cracks, Mr. Frémont, Chief of Works at the School of Mines, has devised the plan of cutting away the crank web in the part between the journal and the crank pin, as shown in Fig. 2. With this arrangement, the dynamic effects are not concentrated at a point, but are distributed around C and D, over the largest possible amount of metal, and the elasticity of which can

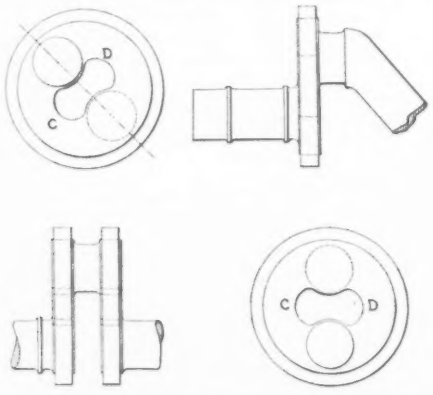


Fig. 2. Method of Slotting the Webs of Crank Axles to Prevent Cracks.

absorb them. This method also removes the defective metal that may occur in the axis of the ingot. Fig. 2 shows the arrangement for double-web cranks on straight axles, as well as for single-web cranks on bent or oblique axles.

Five axles of the oblique type, which showed cracks after runs of 106,480 to 213,195 miles (on engines of the 4:4:0 class) had the webs slotted out in the Frémont plan so as to remove all traces of the cracks. Since then (and up to October, 1908) they had run for from 29,080 to 92,253 miles and had shown no signs of cracks.

Four new crank axles with slotted webs were put in service on engines of the 4:4:2 class (with which cracks are most likely to occur), and have run from 81,230 to 110,193 miles without showing any cracks. Axles made of the same metal, but with solid webs, were applied at the same time to similar engines in the same service; these showed cracks after running less than 62,000 miles.

The above particulars are taken from a paper by Mr. E. Hallard, Assistant Mechanical Engineer of the Southern Ry. of France, in the December number of the "Revue Generale des Chemins de Fer."

TRACK ELEVATION AT CINCINNATI, O., has been delayed considerably by the city's financial limitations, but it is thought that some work may be done this year. Many plans for eliminating grade crossings in the city have been made and agreed to by the railway companies, but no construction has been done. Under the Ohio state law governing the elimination of grade crossings in municipalities, the railways and the muncipality each pay 50% of the total cost, except that where a street railway company is concerned that company shall bear a "fair and reasonable proportion of the city's cost," not to exceed 50% of that cost. At Cincinnati, the municipality has reached the limit for which bonds can be issued, and there are no funds available for paying the city's share of the cost of abolishing grade crossings. An election will be held on May 11 for the purpose of authorizing the city to issue bonds in excess of the present limitations. In this election, however, it is necessary that 66% of the votes cast must be favorable in order to authorize the additional issue of bonds. Should the vote result favorably, the city is in a position to proceed with a considerable amount of work this year. Mr. H. L. Conway is Engineer of the Department of Track Elevation and Subways.

A Suction Ash Conveyor.

An ash conveyor without moving parts in contact with the ashes is shown in the accompanying figures. The simplicity of this design, as herein outlined, is attained by using atmospheric pressure to move the refuse from the ash pits to the storage pile. Fig. 1 shows a general and typical arrangement of the whole apparatus which consists essentially of (1) a conveyor pipe with

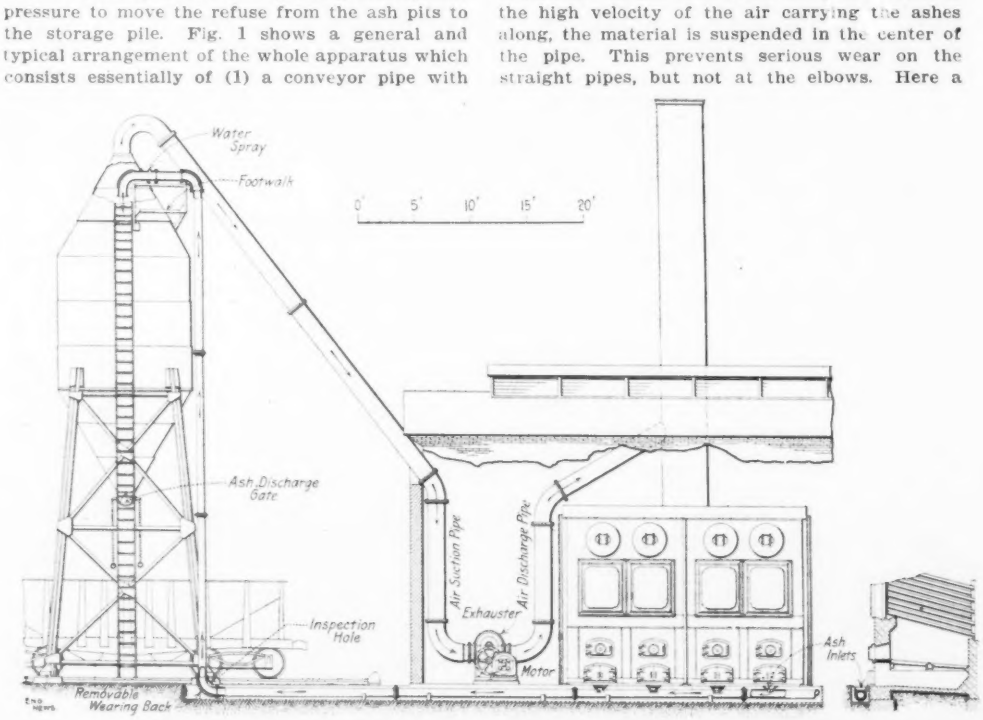


FIG. 1. GENERAL ARRANGEMENT OF SUCTION ASH-HANDLING PLANT.
(Darby Engineering Co., Pittsburg, Pa.)

ash inlets, (2) a water jet for spraying the ashes to reduce the dust and heat, (3) a storage tank, and (4) an exhaust pipe and an exhausting blower.

The conveyor pipe is usually a 6, 8 or 10-in. heavy steel or iron pipe, run so far as possible in straight lines and underground though the latter disposition is not necessary. The capacity of a conveyor is determined by the size of the pipes, the exhauster being of such a size as to maintain the necessary suction pressure. A 6-in. pipe will handle 200 lbs. of dry ashes per minute and the 8 and 10-in. pipes will carry 300 and 500 lbs., respectively. Plants have been installed conveying such refuse 500 ft. with a vertical lift of 125 ft. It is claimed that this can be increased nearly indefinitely by proper design of the suction apparatus. It should be noted that the end of the conveyor pipe is open to the air.

which will pass the intake will be easily carried through the pipe.

It is claimed that there is no corrosion of the conveyor pipe as the ashes are run through dry and the rush of air keeps the pipe dry under all conditions. It has been found that, on account of the high velocity of the air carrying the ashes along, the material is suspended in the center of the pipe. This prevents serious wear on the straight pipes, but not at the elbows. Here a patented split elbow is used, with a removable hard-iron or manganese-steel backing, as shown in Fig. 2.

The water jet is placed at the end of the conveyor pipe just before it enters the separator and storage tank. It is claimed that absolutely no dust is drawn into the exhauster to be blown from the discharge pipe. The storage tank serves to separate the ashes from the entrained air and to store them until they can be drawn out, by gravity, into cars, carts or scows. The tanks as designed have usually been built of steel plate in cylindrical form, with conical tops and bottoms. This is not necessary, however. In cold locations, where there is danger of the ashes freezing in the storage tank, this is covered with some heat insulator or is equipped with a steam coil around the bottom.

The exhaust blower may be, in the smaller and

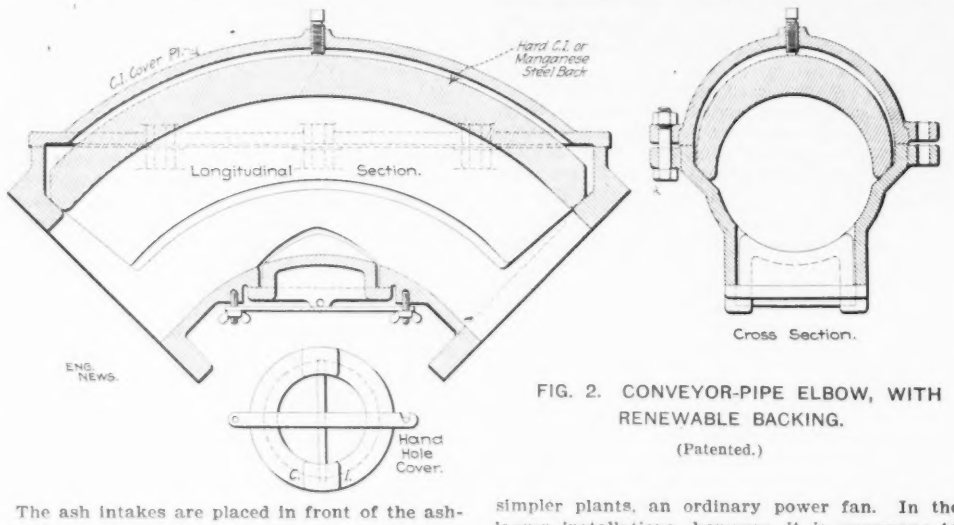


FIG. 2. CONVEYOR-PIPE ELBOW, WITH RENEWABLE BACKING.
(Patented.)

The ash intakes are placed in front of the ash-pit doors of the boiler settings or at any convenient point for shoveling or hoeing the refuse into the intakes. When the conveyor is not in use, a cast-iron cover is placed over the intakes. These openings are of such a size that any material

simpler plants, an ordinary power fan. In the larger installations, however, it is necessary to employ a high-pressure blower to secure the suction pressure of 13 to 32-oz. below the atmosphere. In power plants now operating it is claimed that one man running the ash-conveyor

system takes care of the refuse from 6,000 HP. of boilers, where some eight men have been previously needed to remove it by hand. As the blower needs to be running only when ashes are being removed from a boiler group, the power consumption is intermittent and the average power consumption per hour, per ton of ashes, or per ton of coal burned, may be brought low.

Some 30 of these conveyor plants have been installed in various parts of the country by the Darley Engineering Co., of Pittsburg, who hold the patent rights.

The Selection and Purchase of Coal for Boiler Furnaces.*

By D. T. RANDALL,† M. Am. Soc. M. E.

Furnaces.

It is well known that certain coals are especially suited for locomotive use, others for metallurgical use, for illuminating gas, or for the manufacture of coke, etc., but all coals are considered as a possible fuel for boiler plants. This being so, it is important to know about the design of furnaces and the influence of certain characteristics of coal in order that the best results may be obtained. Furnaces may be generally classified as follows:

(1) The hand-fired grate set in a chamber enclosed by the iron surfaces of the boiler. These boilers cool the gases from the coal and are not suited for use with coals containing more than a small percentage of volatile matter.

(2) Hand-fired grates set in a chamber partially enclosed by brick and with the boiler surfaces just above or near the surface of the fire. These are not suited for burning bituminous coal.

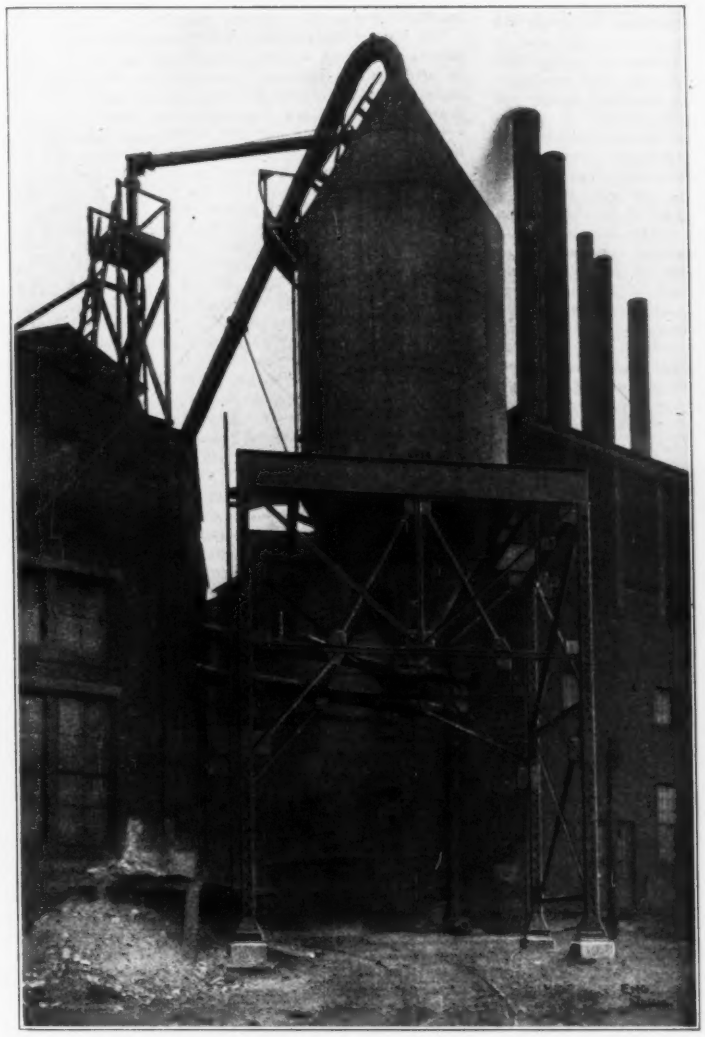


FIG. 3. STORAGE TANK OF SUCTION ASH-HANDLING SYSTEM, PENNSYLVANIA LIGHT AND POWER CO., PITTSBURG, PA.

(3) Hand-fired grates set in a brick chamber with a considerable space for combustion to take place before the gases reach the surfaces of the boiler. This may be accomplished by brick arches, tiles, etc., and in addition piers, baffle walls and other devices are added to assist in mixing the gases and air while within the combustion space. Many of the above when carefully fired give good results and with certain sizes and kinds of coal they may be operated without dense black smoke, but usually not without some smoke. These demand coals low in ash and of large size. Screenings are seldom burned on such furnaces with good results.

(4) Automatic stokers partially enclosed in brick with a small combustion chamber and a short distance from the grates to the boiler furnace. Such settings usually give good results except at high capacities or when the load is changed suddenly. They give off more or less smoke depending on the size and character of coal used. Coals high in fixed carbon may be used with good results.

(5) Automatic stokers enclosed in brick settings with a large combustion chamber and a considerable distance from the grates to the boiler surface. Such settings will burn almost any size or kind of coal with economy and without smoke within reasonable ranges of load.

In general, for most coals, and especially for those which have high percentage of volatile matter, it has been found more satisfactory to install some kind of device which will feed the coal regularly in small quantities, allowing it to become heated gradually, driving off a practically uniform amount of gas to which a proper amount of air can be admitted and burned in a combustion chamber which is sufficiently large to allow of complete combustion in the furnace.

In considering any type of furnace, one should keep in mind the necessity of having a strong draft available. A stack may be supplemented by a forced-draft fan or an induced-draft fan may be used alone or in connection with a forced-draft fan. Most plants do not have sufficient draft at the time when boilers are overloaded.

The amount of draft required depends upon the kind of coal used, the size of the coal and on the load to be carried. Stacks should seldom be less than 120 ft. high. In many cases they must be higher or a fan must be used with them. For most bituminous coals a draft or difference of pressure of ¼-in. of water between the top and bottom of the fuel bed will be sufficient. For small sizes of bituminous coals and for the various small sizes of anthracite coal, the draft required is greater. For buckwheet sizes of anthracite, a draft of 1 in. is frequently necessary.

Coals.

Because a coal is sold at a low price per ton does not of necessity make it the cheapest coal to buy. In choosing a coal when the furnace equipment and other conditions are favorable, the one giving a million heat units at the lowest cost will prove most economical. As a rule, coals mined near the point of consumption and bearing only a small freight charge will be the cheapest coals to purchase and, in most cases, it will pay to install a suitable furnace to burn them. An engineer having full information before him may decide whether or not his furnaces are suitable for burning the cheapest coal and whether or not it will be profitable to change the furnaces. It often happens that, for some good reason, it is impossible to change the equipment and in this case it is, of course, necessary to choose a grade of coal which will make it possible to generate the steam required even though it be more expensive. These conditions arise especially in plants belonging to Government or State institutions and in plants which are rented. Certain characteristics of coal determine the method of firing or the design of furnace required to burn them most efficiently. Among these are the tendency to clinker and to cake in burning. The amount and character of the volatile matter, ash and moisture are also important.

In choosing coal for a boiler plant, it is probable that the chemical comparison, if based upon a representative sample of the coal, is more reliable than a boiler test. The possibility of doing accurate work in a laboratory is greater than in a boiler room, where the fireman may unintentionally influence results by his method of handling a fire. Usually it requires a few days for a fireman to become accustomed to a new coal and even an expert fireman has difficulty in burning the same coal two days in succession and supplying each time the same amount of air per pound of coal. A boiler test is only a rough determination and two tests, one on each of two coals, are seldom sufficient for comparison. If several tests can be run and the averages of the results of these be taken, they will compare pretty closely with the chemical valuation of the coal, provided the coals are of the same general character. Coals high in fixed carbon and low in moisture give better results than those high in volatile matter and moisture. This is true in nearly all furnaces and especially true of boilers not provided with fire-brick furnaces.

SIZE OF COALS.—In the perfect furnace which has been mentioned, the value of the coal should depend entirely upon the heat units which are available in the coal. Unfortunately, the mechanical condition of the coal, even though it is otherwise equally high in B. T. U., is an important element in burning the coal on most kinds of equipment. Usually the smaller sizes are more difficult to burn on account of the difficulty of drawing air through the fuel bed and in many kinds of coal the smaller sizes contain a greater percentage of ash than do the larger sizes.

Owing to the difficulty of burning the smaller sizes of coal, they are usually much cheaper than the larger coals. Improved furnaces with strong draft have been provided in so many plants that very little coal is being wasted on account of its size. The culm banks of the anthracite region are being put through washeries and the good portion sold for fuel. Many coals break up badly in handling. This is especially true of some of the high grade eastern coal. Some of them are delivered with 20% fine coal which will pass through a screen with round holes ⅛-in. diameter. If such coals cake together in burning, this is not so serious as with non-caking coals. With fine coal a much stronger draft is required, which, in some cases, carries a considerable quantity of the very fine fuel off the grate before it is burned and, in case it does not cake, there is also a considerable loss due to sifting through the grates.

HEATING VALUES.—The results of more than 600 steaming tests conducted at the Fuel Testing Plant of the U. S. Geological Survey show that, with the equipment used, coals from Illinois, Indiana, Kentucky, Iowa, Missouri and Kansas may all be burned with practically the same efficiency, even though the heating value varies from 6,000 to 13,000 B. T. U. per lb. of coal, though the ash varies from 8% to 25%, the moisture from 3% to 20% and the volatile matter from 30% to more than 40% in these coals.

The results of these tests indicate that for coals of the same general character the performance of a boiler depends, for the most part, upon the B. T. U. available in the coal, but that also moisture, volatile matter, sulphur and ash have more or less influence on the capacity and efficiency. It is difficult to separate the effects due to any one of these items, except when they occur in large percentages. Coals of the same character may be compared directly on the basis of the B. T. U. in the coal as received without serious error. It is important to note that the heating value should be considered on the basis of the moist coal "as delivered" and not on the dried coal. Coals of different character may be compared on the basis of their B. T. U. values, but account must also be taken of the percentage and character of volatile matter, of the percentage of ash and the percentage of moisture. An allowance for these must be made, depending on the conditions under which the coal will be used.

MOISTURE.—The loss due to moisture in the coal when present in small percentages is comparatively small. Stated roughly, this loss amounts to about 1% for each 10% of moisture based on the "combustible" in the coal. It will, therefore, be seen that an increase of one or two per cent. of moisture in the coal has but little effect on the efficiency of the boiler. However, when moisture occurs in large percentages, as it does in some coals, there is a serious loss due to the heat required to evaporate this moisture from the coal and to the reduction in temperature of the furnace gases. This loss is not corrected for in chemical reports on B. T. U. in coal and an allowance should be made if a coal is high in moisture.

ASH.—It is difficult to determine just what effect the presence of ash may have on the efficiency of the boiler. Apparently it is small. Ash has, however, a decided influence on the capacity at which a given equipment may be operated; it reduces the effective grate area and introduces an added resistance to the flow of air

*Parts of an address delivered before the Illinois Fuel Conference, March 11, 1909, at Urbana, Ill.

†Engineer in Charge of Tests, Technologic Branch, U. S. Geological Survey, Fuel-Testing Plant, 40th and Butler Sts., Pittsburg.

through the fuel bed. There is also a loss of efficiency and capacity due to the necessity of cleaning fires more frequently. This becomes of less importance in types of furnaces where the ash is discharged by dumping or by other automatic discharging devices.

VOLATILE MATTER.—The volatile matter in the coal is also an important element, as it is more difficult to burn than the fixed carbon. The percentage of volatile matter as shown by the proximate analysis is not a direct measure of the difficulty of burning the coal with good efficiency and without smoke. Different coals having practically the same percentage of volatile matter vary in the amount of tars and heavy hydrocarbon given off when they are heated.

In addition, it must be remembered that the volatile matter is not all combustible and that the variation in this respect is great when all the coals in the country are compared. Coals having a high percentage of volatile matter which is nearly all combustible are found to be the most difficult to burn properly. The results obtained from tests on an iron enclosed furnace show a drop in efficiency as great as 10 or 12% in burning coals ranging from 18% down to 45% volatile matter in the combustible. A well designed furnace reduced this loss in efficiency when burning such coals to about 5%.

SULPHUR.—Sulphur usually is in the form of pyrites and is considered an undesirable element. It usually gives trouble from clinker and is often destructive to the grate bars. Its effect depends upon the form in which it occurs in the coal and on the percentage of ash in the coal. Coals having sulphur varying from ½% to 6% or more are successfully burned under boilers and, in many cases, no difficulty is experienced.

THE PURCHASE OF COAL BY SPECIFICATION.—The United States Government is a large user of coal. Its annual fuel bill will amount to nearly $10,000,000. Much of the coal purchased is tested and analyzed. In order to compare the cost of coals used by the Government in the larger cities of the country, it has been customary to calculate the cost on the basis of the number of cents per 1,000,000 B. T. U. It is interesting to note that for last year's contracts the cheapest coal was delivered in Louisville costing only 7.1 cts. per million B. T. U. The cost in Boston for similar coal was 16.3 cts., and in St. Paul the price was 17.1 cts. Anthracite coal was delivered in eastern cities at prices ranging from 8.5 cts. per million B. T. U., for buckwheat coal, to 14 cts. for pea coal, and as much as 20 cts. in some cases for egg and broken coal.

Having decided upon a kind of coal to be used for a plant, the purchaser naturally desires to have some assurance that he may be able to secure the coal in question, or one of practically the same composition, for a given period. This has led to the use of specifications for the purchase of coal. If the size of the contract and other conditions warrant the use of a specification, then the proposal for coal, to be of value, should contain at least two general statements regarding the kind and character of coal.

The bidder should state in his proposal two things: (1) The commercial name and size of the coal to be furnished. The size should be specified within certain limits in order to avoid disputes when coal is delivered. (2) The character of the coal to be furnished, in the following form:

PROXIMATE ANALYSIS.

	Coal as received.	Dry coal.	Coal free from moisture and ash.
Moisture	....		
Volatile matter.....	....		....
Fixed carbon	....		
Ash	....	....	
Sulphur separately determined			———%.
B. T. U. in coal as received (not dry)			———.

The price per ton should be stated for coal of the specified quality. The price to be paid on coal delivered should vary directly with the B. T. U. in the coal "as received"; this value to be modified further, if advisable, by two corrections: (1) For more or less ash in the dry coal. (2) For more or less volatile matter in the "combustible," allowing in all cases 2% or 3% variation without premium or penalty. A limiting value may be placed on the percentage of sulphur in the coal which will be accepted. Corrections for ash and volatile matter are best expressed in the form of a table. In making corrections for variations in the quality of the coal delivered, it may in some cases be more convenient to make all changes in the price on the basis of change of the B. T. U.

The reasons for basing contract on items mentioned above are as follows:

(1) "B. T. U. In Coal As Received" corrects for changes in heating value due to changes in both ash and moisture. The B. T. U. in the coal as delivered being the most direct measure of its value to the consumer, it is reasonable that the contract should be based principally upon this value. This value may be determined and reported directly by the chemist. This results in a premium for better coal and a penalty for coal not up to the standard. As has been shown above, so far as is now known the presence of small amounts of moisture in the coal has but little effect on the efficiency of the boiler, and, as coals from the same mine or group of mines do not usually vary more than 3% or 4% in moisture, it hardly seems worth while to correct for the small amount of heat lost in evaporating it. By basing the value of coal on the B. T. U. as received (moist), the variation in heating value as otherwise affected by the moisture is provided for.

(2) "Ash in the Dry Coal" is independent of changes in moisture in the coal, this figure always being the same no matter what the moisture content may be. Coal delivered from the same mines may vary considerably in the percentage of ash. A reasonable allowance, such as 1% or 2% from the average, would seem to be desirable, as such a variation is almost unavoidable in commercial products. Inasmuch as the heating value is taken care of by the B. T. U. determination, the only remaining corrections to be made for the ash is the extra trouble in handling coal and ashes and the possible reduction of the capacity of the equipment. When the ash greatly exceeds the amount for which the furnace was designed the reduction in capacity may become a serious matter and would justify a rapidly increasing penalty. For the first 3% or 4% increase or decrease in the ash it is only necessary to provide for the difference in the cost of the handling, which is about ½-ct. to 1 ct. per ton for each 1% of ash in the coal.

(3) If volatile matter is to be corrected for, then "Volatile Matter in 'Combustible' " is preferable to "Volatile Matter in Coal." It should be the same, or nearly the same, regardless of variations in moisture and ash in the coal, and it is more properly a measure of the difficulty to be experienced in burning coal, as it is the direct ratio of the volatile matter to that part of the coal which is actually burned. It is reasonable to have a penalty for great variations in the volatile matter from the standard specified, for the reason that furnaces are not all equally well designed to burn coals high in volatile matter. This should not in any way affect the dealer or operator, provided the coal is furnished from the same mine, as the volatile matter should remain practically constant and a reasonable limit should be established within which no change in the price would be made. This variation could well be 3% either way from the standard established. The value for volatile matter should be based on volatile matter in the "combustible" (coal free from moisture and ash), as this value remains nearly constant in the same coal. Premiums or penalties for lower or higher volatile matter may properly vary according to local conditions.

Notes from Engineering Schools.

CORNELL UNIVERSITY.—Through the kindness of Prof. E. Haskell, Director of the College of Civil Engineering of Cornell University, we have been furnished with the following statement of registration and number of failures at mid-year examinations in the various departments of Cornell. These figures, to which we have added a percentage column, are as follows:

	Registration.	No. of failures.	Per cent. of failures.
Arts	873	31	3.67
Law	223	14	6.28
Medicine	207	1	0.48
Agriculture	394	25	6.35
Veterinary	91	3	3.30
Architecture	130	4	3.08
Civil Engineering	569	35	6.15
Mechanical Engineering ...	1,158	40	3.45

HARTFORD TECHNICAL HIGH SCHOOL.—The second report of the Technical High School Commission, of Hartford, Conn., to the Court of Common Council, has recently been published and gives an account of the progress of this project. This Commission was appointed, in accordance with a resolution of the Council, in February, 1908, (1) to study the location, design, cost, work and management of technical high schools in this country; (2) to study the local need of such a school; (3) to recommend a site and to obtain preliminary plans for a proper building. The first report of this Commission recommended immediate provision for such a school to be located in the same block with the present high school. A sum of $1,000 had been appropriated for the preliminary work of the Commission, and after the first report was received by the Council $4,000 more was appropriated. Mr. John M. Carrère, of New York City, became consulting architect, and under his direction a competitive program was drawn up for securing a desirable plan for the building. Three local and two New York architects were invited to compete, each invited competitor receiving $250 to cover the expense of his plans. Other local architects were allowed to compete without remuneration on presenting evidence of recognized ability. Only one firm took advantage of this arrangement.

The competitive program was worked out by Mr. Carrère from detailed information of the requirements of such an institution as found by Mr. W. C. Holden, head of the Manual Training Department of the Hartford Public Schools. This program gives the only clue to the scope of the work in the new school yet published, and from that program, as presented in the Commission's report, the following extracts have been made, in somewhat abbreviated form:

The proposed Technical High School is entirely independent of the existing High School, will be conducted under separate management and will be attended by a separate group of scholars. It is intended (1) to utilize the present manual training building and to extend the equipment into those parts which shall be vacated when the art and other departments are transferred to the new school; (2) the present playground is to be used in common by both schools, the sessions being at different hours this arrangement is perfectly practicable; (3) the present mechanical plant of the High School is to be enlarged for the new building. The competitors need not consider this point and no provision need be made for a mechanical plant in the new building.

The Commission desires that the arrangement will be simple and direct and for the efficient use of the school. It attaches the greatest importance to the question of adequate natural light and ventilation. The Commission desires, while leaving the greatest latitude to the competitors, that they should bear in mind the importance of harmonizing this building with its surroundings and with the other buildings to form an important educational group. The sum appropriated for the cost of this building will be limited. It is therefore necessary that in plan and construction due economy should be exercised.

BASEMENT.—The basement should contain a boys' bicycle room (for 200 wheels); a girls' bicycle room (for 100 wheels); a boys' plunge and showers with lockers for 800 pupils; a girls' plunge and showers, with lockers for 500 pupils (the plunge and showers will not be used simultaneously by over 100 pupils in each); lunch room for boys; lunch room for girls; a central kitchen connected with lunch rooms; boys' and girls' and employees' dressing and toilet rooms; a teachers' room; a janitor's work and repair shop; a battery and switchboard room; one or more general storage rooms; a vault under the first floor vault; a vacuum cleaning apparatus room.

FIRST FLOOR.—The first floor should contain the main entrance, with vestibule and entrance hall. Around this hall, or in its immediate proximity should be: general office, principal's office, reception room; elsewhere, four recitation rooms; a vault connecting with the general office; a book room; men teachers' room; women teachers' room; museum; 13 class rooms; one boys' and one girls' toilet room; 10 coat rooms; gymnasium to extend through two stories.

SECOND FLOOR.—The second floor should contain an assembly hall to accommodate 1,200 to 1,300 pupils, extending through two stories and provided with a small stage and a gallery; nine session rooms; two reception rooms; library and reading room; editorial room; two physics and two chemistry laboratories; two general science laboratories; two private laboratories; three storage rooms; toilet and coat room.

THIRD FLOOR.—The third floor should contain the upper part of the assembly hall and gallery; two domestic science rooms, separated by a pantry; small kitchen and dining room; a domestic and fine art teachers' room; five mechanical drawing rooms; one mechanical drawing teachers' room, with small dark room and blue-print room; two domestic art rooms; domestic art and science teachers' room; sketch room; two free hand drawing rooms; two bookkeeping rooms, two typewriting rooms; two commercial-work rooms; one lecture room, with provision for stereopticon and illustration material; proper toilet rooms.

The successful competitors were Davis & Brooks, of Hartford, with whom Palmer & Hornbostel, of New York City, were associated as Consulting Architects. The estimated cost of the building is $600,000; cost of land, $175,000; cost of furnishings, $40,000. The Commission, at the close of their report, recommended that authorization for the necessary expenditure be secured at the next city election, and that authority for issuing bonds in payment of the work be secured from the State Legislature.

A TORNADO AT ABERDEEN, MISS., April 6, destroyed the depot of the Illinois Central R. R., killing five persons and severely injuring four others.

A DISASTROUS FIRE AT FORT WORTH, TEX., swept the residence section of that city on the afternoon of April 3. The fire started in a barn at the corner

of Jennings Ave. and Petersmith St. and burned over an area ten blocks long by seven blocks wide, destroying 200 residences, four churches, two public school buildings and the Texas & Pacific Ry.'s roundhouse. Fourteen locomotives in the roundhouse were demolished. Six lives were lost, and it is estimated that 500 families were made homeless. The fire spread rapidly under the influence of a high wind and the firemen were entirely unable to effectively oppose it. Reports state that the difficulty of their work was increased by the failure of the water supply. The loss is estimated at $5,000,000.

A CATTLE TRAIN WAS WRECKED on the Cleveland, Cincinnati, Chicago & St. Louis Ry., April 1, in Cleveland, Ohio. One hundred steers were killed outright and 50 more were shot by humane officers. The accident occurred at Scranton and University roads, where there is a curve which makes it advisable for trains to run slowly while passing each other on the parallel tracks. The brakes of the cattle train failed to retard it sufficiently and its locomotive swayed on the curve so much as to collide with a Lake Shore & Michigan Southern switch engine running in the opposite direction on the next track. Almost the entire train piled up on top of the engines, making a heap of wreckage 30 ft. high. The fire which followed was extinguished without difficulty by the Cleveland fire department.

RECORDS OF STEAM SHOVEL EXCAVATION AT Panama were broken on March 2, when Shovel No. 220 in the Empire Construction District of the Central Division excavated 3,941 cu. yds. of material in a working day of eight hours.

A FRENCH TANK SHIP was destroyed by an explosion April 1 in the harbor of Marseilles, France. Twelve members of the crew were killed outright and three others died soon afterward in a hospital. The ship, known as the "Jules Henry," was owned by A. Vimont & Co. and her net tonnage was 1,692. She left the port of Philadelphia Feb. 16 with a full cargo of petroleum. At the time of the explosion, a representative of the Veritas agency was inspecting the vessel. Accompanied by the ship's second officer, he entered the tank hold and the explosion took place while the two men were below. The entire deck is said to have been lifted and a portion of the bow blown off. The ship was almost instantly enveloped in flames, making it impossible to recover all the bodies of the victims.

AN EXPLOSION IN A COAL MINE operated by the Northern Coal Co., at Menor, Coahuila, Mex., March 29, resulted in the death of 35 miners. There were 58 men in the mine when the explosion took place but 23 of these escaped alive. The shaft affected had not been worked for several days and the explosion followed closely upon the descent of the first shift.

An explosion in the Echo mine, at Beury, Fayette Co., W. Va., March 31, killed six of the miners. The mine is operated by the Beury Coal & Coke Co.

A FREIGHT TRAIN FELL THROUGH A BRIDGE on the Mexican International R. R., near Hidalgo, Mex., March 28. The bridge had been weakened by a fire which, according to reports, is believed to have been the work of incendiaries. The accident occurred at night when the condition of the bridge could not be readily recognized. Four trainmen were killed.

A LANDSLIDE CAUSED THE WRECK of westbound passenger train No. 3 on the Union Pacific R. R., March 31, near Castle Rock, Utah. Two of the train crew were killed. Upon striking the landslide, the train was partially derailed and the baggage car, mail car and three coaches took fire and were burned. The remaining seven cars of the train are reported to have been saved by the passengers, who uncoupled them and pushed them one at a time along the track beyond reach of the flames.

THE FORMAL OPENING OF THE VIRGINIAN Railway was held on April 2, with a celebration at Norfolk, Va. The new railway, originally separated into two companies known as the Tidewater Ry. and the Deepwater Ry., extends from Deepwater, Fayette Co., W. Va., on the Kanawha River, to Sewall's Point, at Norfolk. Its length is 446 miles. The line has low gradients, for excess of eastbound traffic, and is planned chiefly for carrying coal, etc., to the seaboard. H. H. Rogers is President; R. Du Puy is General Manager, and H. Fernstrom is Chief Engineer of the new line.

EXTENSION OF THE HUDSON TUNNEL SYSTEM in New York City was approved by the Public Service Commission last week. The northern terminus of the system as hitherto planned was at Sixth Ave. and 33d St., but now it is to be extended from this point north and east to Lexington Ave. and 42d St. alongside the Grand Central Station of the New York Central & Hudson River R. R. The extension was strongly opposed by the Interborough Rapid Transit Co., holders of the operating rights in the municipal subway.

TWO LARGE STEEL BRIDGES are being prepared for active erection work this season, the McKinley Traction bridge over the Mississippi at St. Louis, a short distance north of the Merchants' Bridge, and the Pittsburg & Lake Erie Ry. bridge over the Ohio River at Beaver, Pa. The latter is a cantilever quite similar to the Monongahela River bridge of the Wabash Ry. at Pittsburg, and is only a few feet shorter than the latter, so that it will be the second in length in America.

The new free bridge over the Mississippi at St. Louis, just north of the Eads Bridge, is authorized and active designing work is in progress, Boller & Hodge having been appointed engineers by the city authorities. More remote are the Hudson River bridge and the Hell Gate bridge projects at New York. The Interstate Bridge commissions of New Jersey and New York reported to their legislatures on possible sites recently, and will soon undertake borings at the most favorable sites, to be in position to report definite designs and costs.

OIL BURNING LOCOMOTIVES must be used on railway lines through the Adirondack forests, according to an order just issued by the Public Service Commission of the Second District of New York. The order is issued as the result of an application by Mr. James S. Whipple, Forest Commissioner of New York, and is an outgrowth of the forest fires of the fall of 1908. From the evidence submitted in the case, the Commission concludes that about 40% of the land burned over in the Adirondacks during the fall of 1908 was by fires set from locomotives. The railroad companies proposed to meet the requirements of safety by providing additional safeguards against the escape of sparks and the dropping of coals from the ashpan. They also proposed to clear combustible matter from the right of way; establish a special patrol, with a special telephone system, and run special fire-extinguishing trains. These safeguards the Commission does not consider adequate. An investigation was made of the possibility of introducing electricity for the operation of the lines, but this was found to be financially impracticable, and it was therefore decided that the only feasible plan of preventing fires was to adopt oil burning locomotives. The order of the Commission requires that the locomotives used between April 15 and Nov. 1 in each year, between the hours of 8 p. m., and 8 a. m., shall be required to burn oil in the generation of steam. Locomotives burning coal anywhere in the Adirondack preserves must be subject to the inspection of the Commission, and may not be used until a certificate is issued after such inspection by the Commission's authority. The equipment with oil burning apparatus must be completed not later than April 15, 1910, and at least two locomotives on the Mohawk & Malone R. R., and two on the Delaware & Hudson R. R. must be equipped and in service with oil burning apparatus not later than July 15 of the present year.

COUNT ZEPPELIN with his latest huge dirigible balloon ascended at his factory, at Friedrichshaven on Lake Constance, Germany, early in the morning of April 1 for a flight to Munich, 175 miles away. The airship reached the outskirts of Munich, where military maneuvers were being carried on and after circling about, attempted to land. A strong wind was blowing all during the voyage and at Munich a squall was encountered. The immense airship was unable to land on account of trouble with its engines and it was blown 60 miles out of its course before a landing could be safely made. The airship was then deflated and watched by soldiers, which were rushed to the scene. On April 2d, the balloon was reinflated, by the military balloon corps, which had come up, ascended and went to Munich, where the aeronauts were received with popular demonstrations. The return to Friedrichshaven was uneventful. This performance is considered remarkable, as the landing of the huge rigid balloon was successful under less favorable conditions than when Count Zeppelin's previous models have been wrecked.

TWO STEEL BRIDGES WERE DYNAMITED during the past fortnight. On March 19 the Lake Shore R. R. bridge in course of construction at Indiana Harbor, Ind., was blown up at 7 a. m., immediately after the passage on an adjacent track of a passenger train. No one was injured but the injury to the steel work was extensive. On March 31, at 3 a. m., the steel highway viaduct in course of construction across the meadows back of Hoboken, N. J., a Y-shaped structure connecting Hoboken, West Hoboken and Jersey City Heights, was partially wrecked by the explosion under one of the tower bents of a large charge of dynamite. The injury to the viaduct was confined mostly to the immediate vicinity of the explosion and will aggregate possibly $5,000. The adjacent buildings were damaged to a considerably greater extent.

Both of the contractors on the above bridges employed non-union labor and had had trouble with the unions on that score. As yet the dynamiters have not been found, though suspicion in each case rests on certain union men who have been connected with the controversies.

THE NUMBER OF BOILER EXPLOSIONS which have occurred in the United States and the adjacent parts of Canada and Mexico during the year 1908 is given as 470 in a recent issue of the "Locomotive," the organ of the Hartford Steam Boiler Inspection & Insurance Co., which gives in addition the information summarized in the following table:

	Boiler explosions.	Persons killed.	Deaths per explosion.
1908	470	281	0.598
1907	471	300	0.637
1906	431	235	0.545
1905	450	383	0.851
1904	391	220	0.563

During 1908 the average number injured, but not killed, per explosion was 1.13. During the past 41 years the Hartford Co. has recorded 10,051 boiler explosions, which have resulted either immediately or within a few days in 10,884 deaths and in the more or less serious injury of 15,634 other persons in addition to those killed.

IMPROVEMENTS TO THE WATER-WORKS OF Dayton, Ohio, are recommended by the Committee on Fire Prevention of the National Board of Fire Underwriters (George W. Hoyt, Chairman, 135 William St., New York), in a report just issued. These recommendations indicate that the conditions found at Dayton were less satisfactory than those existing at most of the other places investigated. It is recommended that a competent engineer be engaged to attend to all the engineering work of the department, and that he revise the plans and records of the distribution system. The installation of apparatus to measure the flow of the discharge mains, and of a system for recording water consumption and pumping slip, are also advised. A 20,000,000-gallon reservoir, with a 36-in. main leading from it to the distribution system, is also recommended.

AN INTERNATIONAL EXHIBITION OF RAILWAYS and Land Transport is to be held by the Argentine Republic, at Buenos Aires, from May to November, 1910, in commemoration of the one-hundredth anniversary of the independence of the nation. The board of direction, of which the president is Mr. Alberto Schneidewind, C. E., General Director of Argentine Railroads, is now sending out to interested parties the rules and regulations of the exposition and a schedule of the various industries and appliances which are to be exhibited. These include all manner of railways and tramways, automobiles, cycles, post-office and telegraph appliances, telephones, beasts of burden and vehicles, roads and highway military transportation, municipal street cleaning and fire fighting wagons, hygiene and safety devices. In view of the wonderful progress that the southern republics have recently made and are still making, this would seem to be a field for exhibits for some of the railway equipment houses of the United States.

MORTALITY FROM CONSUMPTION IN DUSTY trades is discussed at length in Bulletin 79 of the U. S. Bureau of Labor. The discussion was prepared by Mr. Frederick L. Hoffman [of the Prudential Insurance Co., Newark, N. J.]. The author considers 42 occupations, grouped in accordance with exposure to dust of metallic, mineral, vegetable-fiber and animal and mixed-fiber origin. We quote from a summary of the bulletin issued by the Bureau of Labor as follows:

Of the deaths from all causes among males 15 years of age and over in the registration area of the United States, 14.8% were from consumption. According to industrial-insurance experience the corresponding portions were 36.9% for occupations exposed to metallic dust, 28.6% for those exposed to mineral dust, 24.8% for those exposed to vegetable fiber dust, and 32.1% for those exposed to animal and mixed fiber dust. The occupation showing the highest consumption mortality was grinders, among whom 49.2% of all deaths were from that disease.

In each occupation group the highest consumption mortality was among persons from 25 to 34 years of age, the proportion of deaths from consumption for that age group being 57.2% in occupations exposed to metallic dust, 47.6% in those exposed to mineral dust, 53.9% in those exposed to vegetable fiber dust, and 53.3% in those exposed to animal and mixed fiber dust, as compared with 31.3% for males in the registration area.

In conjunction with the industrial-insurance mortality experience, occupational mortality statistics are presented from the reports of the United States Census, British official reports, and the occupation mortality statistics of Rhode Island, which furnish additional evidence of the health-injurious effects of exposure in the occupations considered. These injurious effects are reflected in the comparatively small proportion of persons of advanced years, a higher general death rate, and very high specific death rates from consumption and other respiratory diseases.

It is the opinion of the author that by intelligent methods of ventilation and dust removal the consumption death rate among wage-earners can be reduced from 2.2 per 1,000, the rate based on the number of deaths among gainfully employed persons 10 years of age and over in the registration states in 1900, to 1.5 per 1,000, the average rate for 200 small cities, as shown in the mortality statistics of the United States Census for 1901 to 1905. Such a reduction, the author estimates, would result in an annual saving of 22,238 human lives and

would add 15.4 years of life for every death from consumption avoided by rational conditions of industrial life. Such a gain would represent a total of 342,465 years of additional lifetime, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's lifetime at only $200, the total average economic gain to the nation would be $3,080 for every avoidable death of a wage-earner from consumption, representing the enormous total of $68,493,000 as the aggregate annual financial value in the probable saving in years of adult human life. With such results clearly within the range of practical attainment, nothing within reason should be left undone as a national, state, and individual or social duty to prevent that needless, but now enormous, loss of human life from consumption due to the unfavorable conditions in American industry.

Personals.

Mr. E. W. Hess, of Clearfield, Pa., has been elected Borough Engineer at Curwinsville, Pa.

Mr. M. Wassner, Assoc. M. Am. Soc. C. E., has been appointed an Assistant Engineer of the Missouri Pacific Ry. at St. Louis, Mo.

Mr. B. Britton Gottsberger, M. Am. Inst. M. E., has resigned his position as General Manager of the Tennessee Copper Co., Copperhill, Tenn.

Mr. C. R. Hudson, Vice-President of the Mexican Central Ry. and of the Mexican Pacific Ry., has been made also Vice-President of the National Lines of Mexico.

Mr. Bradley Stoughton, M. Am. Inst. M. E., formerly Adjunct Professor of Metallurgy at Columbia University, has opened an office as a consulting metallurgist in iron and steel work at 165 Broadway, New York City.

Mr. E. M. Grime, until recently an Assistant Engineer of the Northern Pacific Ry., has been appointed Supervisor of Bridges and Buildings on the Yellowstone division of the same railway, with headquarters at Glendive, Mont.

Mr. I. M. Ludington, of Rochester, N. Y., has formed a partnership with his sons, Mr. Claude Ludington and Mr. Ira W. Ludington, Jr., under the firm name of I. M. Ludington & Sons, Contractors, with offices in the Powers Bldg.

Mr. C. J. Larimer, Superintendent of the St. Louis Southwestern Ry. of Texas, with headquarters at Mount Pleasant, Tex., has resigned. His successor is Mr. Wm. N. Neff, who has been serving as chief clerk to the president of that railway.

Mr. J. A. Shanahan, formerly Supervisor of Bridges and Buildings for the San Pedro, Los Angeles & Salt Lake R. R., has been appointed Division Engineer in charge of construction of the shops, roundhouse and other buildings to be erected at Las Vegas, Cal.

Mr. Elisha Lee, formerly Principal Assistant Engineer of the Philadelphia, Baltimore & Washington R. R., has become Superintendent of the New York, Philadelphia & Norfolk R. R., succeeding Mr. J. G. Rodgers, whose promotion was announced in this column April 1.

Mr. Edwin P. Dawley, M. Am. Soc. C. E., has retired from his position as Engineer of Construction of the New York, New Haven & Hartford R. R. He will be retained by the railroad as Consulting Engineer, and it is believed that he will enter upon the private practice of engineering in Providence, R. I.

Mr. A. Eugene Michel, Assoc. Am. Soc. M. E., has withdrawn from his position as Manager of the Geo. H. Gibson Co., New York City, and has opened an office as an advertising engineer at 1572 Hudson Terminal Bldg., New York. He will confine his attention to the promotion of steam specialties, power transmissions and machine tools.

Mr. Wilson E. Symons has been appointed Superintendent of Motive Power and Machinery of the Chicago Great Western Ry., with headquarters at St. Paul, Minn. Mr. W. P. Chrysler, formerly Superintendent of Motive Power, will remain in the service as Assistant Superintendent of Motive Power and Machinery, with headquarters at Oelwein, Iowa.

Mr. Edwin J. Haddock, M. Am. Soc. M. E., has resigned his position as Chief Engineer of the chain department of the Jeffrey Mfg. Co. and has opened an office as a designing engineer in the Shultz Bldg., Columbus, Ohio. He will give special attention to the design of coal mining equipment and stone and gravel crushing and screening plants.

Mr. J. W. Paul, in charge of the mine rescue work of the U. S. Geological Survey, Technologic Branch, sailed April 3 for Europe to investigate methods of testing safety lamps and explosives and of conducting mine rescue operations. Mr. Paul will be accompanied, after reaching Europe, by Mr. Axel Larson, who was formerly with the Nobel Explosive Works of Denmark.

Mr. Edmund Pennington, who recently became President of the Minneapolis, St. Paul & Sault Ste. Marie Ry., as announced in this column March 18, has become President of the Wisconsin Central Ry., which has been leased by the M., St. P. & S. Ste. M. Ry. Mr. Pennington succeeds Mr. Newman Erb, who has been President of the Wisconsin Central only since January, 1900.

Obituary.

G. Charles Conner, Manager of the Philadelphia office of the Sprague Electric Co., since February, 1903, died in Philadelphia, Pa., March 27, of blood poisoning which followed an operation for an intestinal abcess.

John Corey Hersey, Chief Clerk of the entry division in the naval office of the Custom House at New York City, died March 30 at his home in Flatbush, Long Island. He was born at Lowell, Mass., in 1847, and, after graduating at the Sheffield Scientific School of Yale University with the class of 1868, he was employed for several years as a civil engineer by the Northern Pacific and by other Western railways. He had been in the Custom House service for the past 30 years.

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.
April 27 to 30. Annual meeting at Louisville, Ky. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 4-7. Spring meeting at Washington, D. C. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 6-8. Annual meeting at Niagara Falls, Canada. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AIR BRAKE ASSOCIATION.
May 11-14. Annual meeting at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 18-20. Annual meeting at Cincinnati, Ohio. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN RAILWAY ASSOCIATION.
May 19. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Place, New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 25-27. Annual meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 1-4. Annual convention at Atlantic City, N. J. Secy., W. W. Freeman, 29 West 39th St., New York City.

AMERICAN WATER-WORKS ASSOCIATION.
June 8-12. Annual convention at Milwaukee, Wis. Secy., John M. Diven, 14 George St., Charleston, S. C.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 21-23. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 39 Old Colony Bldg., Chicago, Ill.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
June 21-23. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, C. & E. I. R. R., 327 La Salle Station, Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 23-25. Annual meeting at Detroit, Mich. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 28. Annual convention at Frontenac, N. Y. Secy., Ralph W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 3. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting held in New York City April 7, a paper on "The Sixth Street Viaduct of Kansas City," by E. E. Howard, was presented for discussion. This paper was printed in the February "Proceedings."

BROOKLYN ENGINEERS' CLUB.—At a meeting to be held April 8, Mr. J. E. Jennings will present a paper entitled "Steel Transmission Towers," illustrated by lantern slides, in which he will discuss their design, tests, shop work and galvanizing, shipping and erection.

NEW YORK ELECTRICAL SOCIETY.—A meeting was held at the New York Hippodrome, March 31. At the conclusion of the regular Hippodrome performance the members assembled on the stage and were addressed by Mr. Arthur Williams on "The Electrical Equipment of the Hippodrome."

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.—The 86th annual meeting will be held April 28-29 at Boston, Mass. Papers are expected on the following subjects: "Advantage of Variable Speeds for Ring Spinning"; "Commutator Grinding"; "Cotton Fiber Substances and Their Properties"; "Economy in Steam Generation"; "Improvement in Lighting Large Textile Areas with High Efficiency Lamps"; "Scientific Methods of Warp Sizing"; "The Textile School, Its Scope"; "Transportation for Mill Yards."

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At the meeting of the Mining Section held in Montreal April 1, Mr. J. B. Porter, M. Am. Inst. M. E., made an authorized announcement in regard to the manufacture and qualities of monel metal. This announcement was followed by brief papers by Mr. A. Stansfield, M. Am. Inst. M. E., and Mr. E. Brown, M. Can. Soc. C. E., on the metallurgical and physical qualities of the new alloy. The composition and principal advantages of monel metal were noted in Eng. News, Feb. 4, 1909, p. 127.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The annual meeting of the Boston Society of Civil Engineers was held in the house of the Boston City Club on Wednesday, March 17, 1909. The meeting marked an innovation in combining the annual meeting, the annual dinner, and an informal smoker, in a single all-day function, and was eminently successful.

The business meeting was called to order at 11 a. m. by Mr. J. R. Worcester, President, with about 150 members present. The annual reports of the various officials showed the society to be in a prosperous condition, with a membership approaching 700, and with a permanent fund exceeding $23,000.

The report of the Committee on Larger Membership and Clubhouse, submitted in printed form, elicited a considerable discussion, and it was voted by a large majority that the Board of Government, the Committee on Permanent Quarters, and the Committee on Larger Membership and Clubhouse should constitute a joint committee to prepare definite plans for a joint engineering and technical societies building, with authority to incur the necessary expense for investigations and plans, and to find out definitely what other societies would rent quarters on long-term leases if the plan should be carried out. The sentiment of the meeting seemed to be universally in favor of something in the way of better quarters and bringing the several technical societies in Boston together in a single club. The opposition to this plan seemed to come wholly from those who favored a technical club on the line of the usual social club, from which the various societies should rent quarters. The greater part of the members present, however, evidently believed it impossible to support such a club.

President Worcester then delivered his annual address. After reviewing some features of the society's activities during the year, Mr. Worcester spoke of the necessity of infusing new blood into any organization if it is to make progress. He deprecated the fact that the practice of the Boston Society had been to elect, as a rule, only the older members to official positions. Thus, during the past year, presidents at the time of their election had been members of the society for an average of 23.1 years, vice-presidents 16.6 years, secretaries 25 years, and directors 11.1 years. The average length of membership of these and other officials at the time of their election had been between 17 and 18 years. He remarked:

> Is it according to human nature that men who joined the society at about the time the new members were donning their first trousers, can so direct the society as to make it attractive to the newcomers?

He then suggested a change in methods of nomination and in the statements sent out with letter ballots, both changes being designed to bring in younger members to direct the affairs of the society. At present three candidates are presented for every office. This, Mr. Worcester stated,

> besides bringing the unpleasant sense of defeat to two-thirds of the men voted for each year, has the effect of inevitably forcing the membership to make a choice between men of widely differing terms of service in the society. The letter ballot does the rest of the evil. Those who vote, in a very large proportion, are men who seldom, if ever, attend the meetings. They do not know the younger members. In the list of candidates, they are likely to find one whom they may know, or, at least, know by reputation, and they are pretty sure to vote for him. He may be the best man for the position, but he is more likely to be one whose professional advancement has made such demands upon his time that he has lost touch with the society, and, in taking it up at a personal sacrifice, cannot readily acquire the spirit of the younger element.

Another interesting and suggestive line of discussion in the president's address related to a possible means of increasing the attendance at the meetings, securing a grade of papers of more interest to the membership, and eliciting fuller discussion of the papers. Papers descriptive of engineering works actually carried out seem to interest the membership more than technical or theoretical discussions. The printing and circulation of papers in advance might be an aid in bringing out discussion.

The canvas of ballots showed officers elected for the coming year, as follows:

President, George B. Francis.
Vice-President, Charles T. Main.
Secretary, S. Everett Tinkham.
Treasurer, W. S. Johnson.
Librarian, Fred'k I. Winslow.
Director, Fred'k H. Fay.

The meeting then took a recess until the close of the annual dinner, and the members, to the number of 200 or more, proceeded to the large hall where the dinner was served at about 2 p. m.

At the end of the dinner Mr. George B. Francis, the newly-elected president, was introduced. After expressing his appreciation of the honor, he presented an address descriptive of the railroad terminals in most of the large cities of the world, profusely illustrated with stereoptican views. At the close of the address the annual meeting adjourned at about 5 p. m.

The smoker in the evening was attended by 250 or more members and their guests, and proved to be a most enjoyable occasion. Light refreshments were served, and songs, especially written for the occasion, added to the jollity of the occasion.